MIETE

MASTER IN INNOVATION AND TECHNOLOGICAL ENTREPRENEURSHIP

The importance of an innovation management system

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Dissertation

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Abstract

Innovation management is a subject every time more getting emphasised by companies and undergone by researchers. In this light have been launched and are continuously in development practice-based and scientific, nationally bounding and worldwide frameworks for systematically fostering innovation.

In this dissertation seven influential management frameworks from both a scientific and consultative approach were analysed and various models´ scopes were benchmarked in comparison to each other. Interestingly, this revealed that all the models showed a high similarity. Based on the frameworks´ auditing tools a questionnaire was designed and used for obtaining empirical input for this dissertation.

Qualitative data was favoured to give more insight to the implementation impact and therefore personal interviews were conducted. All together nine mainly Portuguese origin companies were interviewed; many of them with subsidiaries and/or international commitment. Five of the companies were *NP4457:2007* certified which is a Portuguese national standard for Research, Development and Innovation (RDI) management. Other four non-certified companies were brought in to analyse their similarities and differences compared to certified companies´ RDI management.

The information technology (IT) sector was chosen because previous studies revealed that this sector has the highest standard NP4457:2007 adoption rate and importantly the author of this dissertation originates from Estonia where the IT sector is considered as one of the backbones of the new epoch of economical development after re-gaining independence in 1991.

Results indicated that national standard certified and companies with internally developed RDI system presented higher information systematization and its documentation. Moreover, intriguingly it was noted that there is a higher motivation for framework based RDI management among well market-established companies. For new or startup companies innovation management could be considered an element that is naturally part of their activities but having to certify RDI when the company still has not reached a reasonable size was often considered too large an obligation coming from national financial incentive1.

According to the certification impact on the system effectiveness was concluded that organizational strategy for innovation, commercialisation and diffusion of the products/services and innovation outcome were the innovation management sub-processes that can be considered to benefit the most from fostering a formal innovation management system.

Keywords: innovation management, management models for innovation, innovation management standard, certification of RDI management system.

[1] *Company Investment Incentive Systems 2007-2013* under Quadro de Referência Estratégico Nacional (QREN) *National Strategic Reference Framework.*

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[2] INESC Technology and Science (INESC-TEC) Associate Laboratory coordinated by INESC-Porto, Institute for Systems and Computers of Porto

[3] In Appendix A can be found the respondents names and titles.

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1 Introduction

1.1 Scope of this dissertation

The relationship between company´s economical yield and innovation performance was introduced by Schumpeter already in 1934 (Sánches e Ferrás 2011, Mir e Casadesús 2011). Subsequently many theories have been developed to help understand how innovation occurs and what the main factors that foster innovation in the business environment are.

According to dictionary definitions, innovation is *a new idea, method, piece of equipment, etc*[4], *the action or process of innovating*[5] and means *introducing something new*[6]. Joseph Schumpeter when laying out the foundation to innovation considered a series of five important aspects in his *The Theory of Economic Development* that have, up to today, generally maintained the core fundament for distinguishing innovation. Schumpeter (1934) considered innovation to be when it i) occurs through the introduction of new good, ii) introduction of new method of production, iii) opening of new market, iv) use of new supply or v) adaption of new way of organizational structure. (Godin 2008)

The organizational urge for innovation management has led many consulting firms developing frameworks to support innovation management. At the end of 2012 there were two proposals made to the International Standardization Organization (ISO) by Brazilian and French local standardization bodies in order to develop an internationally binding innovation management standard. For some scientists, nevertheless standardizing innovation is a never-ending dilemma as trying to standardize innovation management is a contradiction and restrictive by its very nature of "newness". There are postulates that the quantifiable nature of science cannot uncover the internal meaning and perceptions of individual ideas, thoughts or creation. Moreover, measuring certain outcomes using predefined tools is too narrow or meaningful. Other fields of thought suggest that successful standards not only fill a need, but allow for innovation to be accomplished in an expected and predefined way.

1.2 Motivation

Motivation to focus this dissertation on innovation management dates back to the author´s previous experience with ISO 9001 Quality management and ISO 14001 Environmental management systems. In 2011 the author wondered after learning about Portuguese national Research, Development and Innovation (RDI) management standard NP4457:2007 if there existed a similar ISO framework for innovation management. The response from professor, Alexandra Xavier, who eventually was to became the supervisor of this dissertation was in 2011 that there was created a CEN-STAR who decided not to develop o ISO standard but a Technical Specification[7]. Nevertheless, in 2013 there was a new initiative, a Brazilian local certified body proposed ISO to develop internationally binding standard for Research, Development and Innovation (RDI) management. Development trends show that *there will be an ISO standard on innovation management* therefore the author of this dissertation has captured with her interest an important milestone in the IMS developement history.

[4] MacMillan Dictionary
[5] Oxford Dictionary
[6] Merriam-Webster Dictionary
[7] CEN/TS 16555-1:2012 Innovation Management – Part 1: Innovation Management System

1.3 Objectives

The aim of the empirical research conducted in the scope of this dissertation is to answer two questions. Firstly, what the advantages of implementing a RDI management based on a certified system are. And secondly, what is the implementation impact of certified innovation management system based on the Portuguese sample.

1.4 Methodology

Elaboration of this dissertation is based on the following starting points:

- I phase: State of the art of the innovation management and regarding frameworks for practical application;
- II phase: Conducting a case study including nine information technology (IT) companies: five NP4457:2007 certified and four non-certified companies. For obtaining data input questionnaire was developed and personal interviews were conducted with company representatives.
- III phase: Presenting and analysing the results from case study according to the references and objectives of this dissertation.

In the Table 1 are identified outputs of each of the objectives.

Phase	Objective	Outputs
I phase State of the art	Build the knowledge about the innovation management theory and reference documents used to foster systematic innovation management.	Definitions of innovation, innovation management systems. Description and benchmarking of the models associated to innovation management and their auditing tools.
II phase Case study including nine information technology companies	Selecting and contacting companies and conducting interviews with them. Transcription of the interview information.	Organized case study data.
III phase Presenting and analysing the data	Include the obtained case information to the dissertation. Identifying the NP4457:2007 adoption advantages and disadvantages.	Overview of the obtained case study data. Critical analyse and discussion of the data obtained according to the literature review conducted.

Table 1. Dissertation methodology.

Primarily result of this research is i) this dissertation. Beyond the dissertation this research outputs ii) a scientific paper (accepted for oral presentation) to ALTEC[8] conference co-written with a colleague from INESC-TEC "*Understanding the benefits of standardizing innovation management*" and iii) an independent volume is foreseen including full transcriptions from the case studies.

[8] ALTEC Latin Ibero-American conference on Management Technology , available at http://www.altec2013.org

1.5 Dissertation outline

In the first chapter is the introduction to the chosen subject, motivation leading to choosing the topic, the outcome objectives of the dissertation, a short explanation of the methodology, analysis process and the outline of how the dissertation is framed.

In the second chapter is reviewed relevant literature on the subject. Innovation definition development together with types, degrees and categories of innovation adaption are presented. To continue innovation management is analysed from the systematization viewpoint and dilemma of standardizing innovation management is introduced to show the two different points of views on innovation management practices.

To understand better the nature of innovation management practices, different frameworks for fostering systems of innovation management were analysed and benchmarked. For developing a questionnaire frameworks auditing tools were compared and relevant topics were included in the interview guide used in the scope of the empirical research of this dissertation.

In the third chapter an overview of the Portuguese national RDI management standard NP4457:2007 is given.

In the forth chapter scope together with the research objective of this dissertation is introduced in more detail and all the methodology used is described.

Fifth chaper is dedicated to presenting the results obtained throughout the case studies.

In the sixth chaper obtained results are analysed in the respect of the research objectives.

In the sevent chaper can be found bibliographical references.

2 Literature review

2.1 Innovation definition

As considered according to Schumpeter innovation occurred either when i) new good was introduced, ii) new method of production was adapted, iii) entry to new market was established, iv) new supply was used or v) new way of organizational structure had been adapted(Godin 2008).

Freeman, a world-known researcher from the Science and Technology Policy Research Unit, University of Sussex (SPRU), nominated Schumpeter as the "father" of innovation (C. Freeman 2003) and was himself considered as one of the most active promoters of Schumpeter (Godin 2008), Freeman an innovation baseline identifying that industrial innovation includes the technical, design, manufacturing, management and commercial activities involved in the marketing of new (or improved) product or the first commercial use of a new (or improved) process or equipment (C. Freeman 1982).

Rogers (Rogers 1983) definition of innovation "an idea, practice, or object that is perceived as new by an individual or other unit of adoption" identifies shortly and clearly the essence of innovation – adopting something that is perceived new.

A more global definition offered by the Organization for Economic Cooperation and Development (OECD) is that: *innovation consists of all those scientific, technical, commercial and financial steps necessary for the successful development and marketing of new or improved manufacturing products, the commercial use of new or improved processes or equipment or the introduction of new approach to a social service* (OECD 1994). This definition includes newly the private economy as a possible beneficiary of the innovation process.

Over time, the approach to innovation continues to develop and in the 3rd updated edition of the Oslo Manual (OECD and Eurostat 2005) innovation is considered as the implementation of a new or significantly improved product (goods or service) or process, a new marketing method, or a new organizational method in business practices, workplace organization or external relations.

NP4457:2007 has adopted the abovementioned Oslo Manual viewpoint for innovation definition with a slightly different wording "*innovation refers to the implementation of a new and significantly improved solution for a firm […]* "completing moreover that "*[…] with the aim of reinforcing the companies´ competitive standing, improving its performance or its know-how*"(Instituto Português de Qualidade 2007b).

British standard *BS 7000-1:2008 – Design management systems: Part 1: Guide to managing innovation* innovation definition: "*Innovation is the creation of change that introduces a significant element of novelty in thought and action*"(British Standards 2008) shows a similarity to Rogers´ as it identifies the essence of innovation.

It can be seen that between authors the specific definition and meaning of the term innovation varies along innovation types, degrees, phases and functional areas involved as professionals have different views on the nature of innovation. (Goffin e Mitchell 2005)

2.1.1 Types of innovation

Goffin & Mitchell refer to types of innovation as dimensions of innovation and identify product, service, process and business process innovation. In the scope of Portuguese NP4457:2007 national RDI management standard is applied the Oslo Manual 3rd updated version (2005) definition by considering product, service, organizational and marketing innovation. (Goffin e Mitchell 2005, Instituto Português de Qualidade 2007b)

According to Goffin & Mitchell (2005) product innovation is considered as a first dimension of innovation and service innovation is regarded independently as a second dimension as it can create services enabling differentiation of products compared to competitors. Whereas, the NP4456:2007 product innovation definition is seen to join these two dimensions by adopting as described in the OSLO Manual 3rd ed. (page 48, 156) *"the introduction of a good or service that is new or significantly improved with respect to its characteristics or intended use including significant improvements in the technical specifications, components and materials, incorporated software, user friendliness or other functional characteristics".*

Process innovation refers to new or enhanced production process in the manufacturing (Goffin ja Mitchell 2005) and in the scope of NP4456:2007 it is considered as new or significantly improved methods of logistics, delivery or distribution by adapting this view from the manual where it stands as *"implementation of a new or significantly improved production or delivery method which includes significant changes in techniques, equipment and/or software"* (page 49, 163). Improvement other than that directly affecting manufacturing (faster transactions, improved supply chain) is considered separately under business process innovation (Goffin e Mitchell 2005).

Business process innovation is considered to be the improvement of any business processes apart from the actual manufacturing. Supply chain updating or applying innovative approaches to organizational aspects are two examples of this type of innovation. Similarity to organizational innovation can be noted. (Goffin e Mitchell 2005)

Organizational innovation according to Oslo Manual (2005) is defined as "*the implementation of a new organizational method in the firm´s business practices, workplace organization or external relations",* meaning the routines and procedures for conducting the work; improved distribution of responsibilities, decision-making and structuring or integrating (business) activities. New ways of organizing relationships with other firms according to the Oslo Manual is also considered organizational innovation; nevertheless Goffin & Mitchell define it as business process innovation.

Marketing innovation is "*the implementation of a new marketing method involving significant changes in the product design or packaging, product placement, product promotion or pricing"* (OECD and Eurostat 2005). It is important to note that design can be considered as a process innovation according to the NP4457:2007 in case it does promote significant change in the product's functional characteristics.

2.1.2 Degrees of innovation

Goffin & Mitchell identify innovation degrees as breackthrough and incremental innovations. However, according to Henderson & Clark (1990) this view is incomplete and they introduce with their architectural innovation concept two more levels to capture the influence that seemingly small improvements in technological products can cause on industry leaders:

modular innovation and architectural innovation. British standard (2008) also indicate disruptive innovation as the stage with major changes, followed by breakthrough innovation, radical innovation, incremental innovation, continual improvement, and ad hoc changes. Commonly the terms of radical and incremental innovation are more used terminologies, radical and breakthrough innovation are often referred to as the same.

Radical innovation occurs when some breakthrough is achieved, like developing a new technology, creation of new demand and building up related markets by establishing a new dominant design where new components are linked together in a new architecture. (Goffin e Mitchell 2005, Henderson e Clark 1990)

Incremental innovations are considered minor changes or updates to existing products that are relevant but do not change drastically the original product. They occur when an established design exploits new potential or existing design is extended and are component based, often reinforcing the dominance of the company. (Goffin e Mitchell 2005, Henderson e Clark 1990)

Modular innovation occurs when a core component is replaced but the architecture is maintained, meaning that substantial new knowledge is developed (Henderson e Clark 1990).

In architectural innovation the interaction between the components is the main aspect in cause, where company´s architectural knowledge is destroyed but product component knowledge is maintained the same(Henderson e Clark 1990).

Disruptive innovation is an innovation process with a significant adverse effect within and/or outside an organization that is out of the means of control and not possible to influence in the short term.(British Standards 2008)

All of thise innovation degrees are futher induced by degrees of newness. Starting from the first indicator and highest risk involved they are, new to i) the world, ii) a region, iii) a country, iv) a sector/industry, v) a market, vi) an organisation, vii) a site, viii) a departmant and ix) an individual. (British Standards 2008)

2.1.3 Categories of innovation adaption

Roger (1983) classifies adoption categories in five idea types as he calls them: innovators as the venturesome, early adopters as the respectable, early majority as the deliberate, late majority as the skeptical and laggards as the traditional. In the British standard (2008) in the decreasing originality order the levels are: first mover, first to market, fast follower, mainstream, late developer, opt out/sidelined. Frequently used terminology includes three of them with a slightly different wording i) innovators as the first-to-the-market or first mover, ii) early adopter as the fast follower or as the mainstream, iii) late majority as the late follower.

First-to-the-market or first mover strategy means that company drives to come out with new to the world ideas. This commonly requires high investment in R&D and risk tolerance. The main profit comes from on early adopters and idealistic followers, to whom they are seen as role models. This type plays an important role in the diffusion process by importing the innovation from outside the known boundaries by launching a new idea. (Rogers 1983, British Standards 2008)

According to late follower strategy a new idea is adopted after the majority has already done so. There is no other way of continuing the business than upgrading for the new technology. It is an answer to both economic necessity and increasing pressure (Rogers 1983).

2.2 Systematization of innovation management

Schumpeter (1934) recognized that clustering of innovations led to extensive growth of new business launches (C. Freeman 2003). The realization of the possible benefit revealed from being innovative, made managers desire to systematically groom activities boosting competitive advantage. In conjunction with this recognition scientific research also increased and in Science Direct the number of papers and books published since the 80´s, in relation to about innovation management, evidences exponential growth tendency (Eveleens 2010) and is continuing to rise. Every time more of the creation of innovation-based values are located at the heart of business priorities the desire to be successful is affirmed (Little 2013). Keith Goffin says "*innovation management is about getting more and better products successfully to market*". Portuguese standard NP4457:2007 completes Goffin´s idea by emphasizing that the central objective is company sustainable competitive advantage as it "*[…]aims to establish a normative framework that contributes to better performance of organization, focusing on their Research, Development and innovation management system (RDI) as a fundamental method to create knowledge and transform it into economical and social wealth*". In the model development was taken into account the design, the alignment and the evaluation of the critical dimensions of the RDI process to foster the transition of organizations of any type and size, into the knowledge-based economy (Instituto Português de Qualidade 2007b).

A. D. Little justifies "*integrated innovation is all about taking innovation approaches that were once the domain of New Product Development (NPD) only – such as idea management, stage gates and portfolio optimization – and applying them consistently as an integral part of business strategy to achieve not only growth but also competitiveness*." (Eagar, van Oene e Boulton 2011)

2.2.1 Innovation management systems

One might question what an innovation management system is? According to Tang (Tang 2003) a management system is defined as "*organizational structure, responsibilities, procedures, practices, activities and resources needed for the development, implementation, achievement and maintenance of an organizational policies and objectives*". Innovation management systems can therefore be described as structured and regularly practiced ways of running organizational activities contributing to its innovativeness capacity and performance.

A fundamental cycle of innovation process according to Schumpeter (Schumpeter 1939) starts with idea generation that is commonly called the invention or discovery phase, continues with innovation which in reality means the first economic application of the invention, and the conversion which follows when successfully fostered by the third and final step, diffusion where an outcome of the innovation is adapted by the consumers in general. Various frameworks have been built on this ageless understanding of innovation management process.

According to Goffin & Mitchell the phases form a funnel which starts with an idea generation phase where promising ideas stay on the filter and continue whereas not so

innovative are filtered out. Next, choices of best ideas where already more complex concepts are developed around the previously selected ideas. In this phases less promising concepts are rejected and some are turned into initial idea generation phase for "recycling". In the third and final, implementation phase, the formerly developed concepts are taken to the project level. When not killed in this phase, the idea seed planted and nurtured throughout the developement process is launched to the market. The process of typical innovation process is complex and any idea must progress through the development phases hereinbefore it is comercially viable.

Those systems can be organically developed based on the best practices and the organization needs. Nevertheless, it is becoming common for companies to adapt or acquire an already existing framework developed by some other institution (Goffin e Mitchell 2005) as they are proven to deliver higher integration.

2.2.2 Innovation management frameworks

An innovation management system has a structured integrated instrument for managing related recommended activities that depending on the author(s) is called a framework, model, manual or even an engine and when developed by a certified entity the innovation management system can be launched as a standard. Commonly, together they are identified as frameworks and this terminology is therefore used in the current dissertation.

Innovation management normally includes a set of tools that are frequently related to R&D activities but not exclusively. Published best practices have revealed that company competetive edge is achieved not only via research and development work but that a well structured internal process flow in the organisation also plays an important role and therefore the need for top managament to be strongly involved and motivated in the innovation management process has been underlined (Goffin e Mitchell 2005). Innovation management is fostering both interdependent and inter-related processes of organisational activities that are directed to improve its output and performance.

The skills required to manage innovation effectively differ from general management principles as it demands that managers match technical expertise with soft skills. To promote creativity, areas such as technology and project management are in need of integration with people management, plus managers need to be alert about risk management. (Goffin e Mitchell 2005)

As the process of innovation is complex, managing innovation is therefore even more sophisticated, hence it takes time to develop and constant effort to maintain. Everything starts from the understanding of how the innovation process could successfully influence development, mainly based on the empirical studies conducted among successful companies (Eveleens 2010). There is a body of literature on best practices available from pioneer companies and various international consulting firms offering service to managements in order to facilitate the implementation of an integrated innovation management system. Goffin & Mitchell (2005) identify when interviewing managers that integrative tools for innovation management are requested, rather than ad hoc collection of snippets of best practices. When developing innovation management frameworks, innovation research constantly moves from theory to practice and the other way around, to obtain the relevant and reliable data(Eveleens 2010).

Professor Joe Tidd[9] has emphasized that "*developing systematic innovation management frameworks that travel beyond the NPD function is an important goal for future business success*" (Eagar, van Oene e Boulton 2011).

2.2.3 Standardizing innovation management

What is the role of standardization in innovation? Standards are developed to normalize technical knowledge on relevant issues to obtain uniformity in how the processes are conducted in the companies and organizations. (The European Parliament and the Council 2012)

Looking at machinery producers or pharmaceutics, it is obvious that customers require them to follow some regulations. Consequently, standardization is considered as something positive. However, from the perspective of the management and staff, regulations have a tendency to be felt as restrictions, especially when speaking about innovation which is a creative process in its nature. The question of standardizing innovation remains complicated due to much of its occurrence being perceptible.

João Bento, the coordinator of the Portuguese DSIE[10] initiative has explained that if there are convictions about the necessity to innovate and the company has complex activities for innovation, there should be a system to manage it. A management system submitted to a standard ensures that the system does not have gaps through audit and full documentation.(Pimental 2010)

Best practices have demonstrated that systematized innovation activities have helped companies to reach success and establish competitive advantage over their rivals (Little 2013, Koetzier, Kristensen ja Alon 2011, COTEC 2010, Engel, Wagner ja Hubbert 2007). This has led to the development of new tools and approaches that are constantly launched and offered to companies (Little 2013).

2.3 Dilemma of standardizing innovation management

Innovation is a creative process and it is true that children are more creative than adults[11]. When a human being grows up, the amount of rules and regulations that one has to follow vanishes natural creativity (Land e Jarman 1993). This should be understood when examining the standardization rules that inform innovation performance within a company, is the innovative management framework a positive force for building an environment for adults

[9] Professor of Technology & Innovation Management, SPRU, University of Sussex

[10] DSIE initiative stands for Sustained Development of Company Innovation

[11] 1968 study by George Land, a general systems scientist interested in the development of creative performance, revealed that we are naturally creative as children, Over a 15 year period he distributed among 1,600 5-year-olds a test designed to measure creativity. This test was used by NASA to select innovative engineers and scientists. George Land used the test to re-tested the same children at 10 years of age, and again at 15 years of age. 5 year olds showed 98% of creativity, 10 year olds 30%, 15 year olds 12% and when the same test was given to 280,000 adults performed 2% for their creativity. (Land e Jarman 1993) http://blog.entrepreneurthearts.com/2009/03/04/are-we-more-or-less-creative-as-we-age/, accessed on the 15.08.2013

(working people) to nurture their creativity or does it hinder personal creativity and company growth?

To support the SMEs the European Commission has promoted the Europe INNOVA program[12] since 2000 which in its early stages has a focus on innovation management consulting approaches and self-assessment tools that SMEs could use to define their proficiency in innovation management (INNOVA 2006). Ideally European standard in Innovation Management was planned to develop over a period of 2006-2009 under the IMP3ove project which is an initiative from the European Commission. However, time has shown that this has not yet happened. Sack (Sack 2011), points out that there is a natural tension between innovation and standardization by suggesting that when standardization occurs too early, innovation could be stifled.

Records from management consulting firms nevertheless continue to refute this argument. Numerous available case study results present positive feedback in the light of innovation management practices(Koetzier, Kristensen ja Alon 2011, Thuriaux-Alemán, Eagar ja Johansson 2013, COTEC 2010, INNOVA 2006, Engel, Wagner ja Hubbert 2007). Sack (Sack 2011) supports that innovation and standardization can go hand in hand identifying that "*successful standards not only fill a need, but allow for innovation to be accomplished in a standard way"* – and adds that the challenge lies in meeting the right balance between standards and innovation.

However Müller-Prothmann (Müller-Prothmann 2006) disagrees and states that "*innovations are major drives for national economies and individual companies operation on competitive global markets"* his main arguments are that empirical studies and practical experiences demonstrate that increased planning performance and efficient process design do not contribute to sustainable innovation success as "*common innovation management models are not flexible enough and do not provide sufficient support for dynamic (re-) actions to meet the real conditions of complex processes and environments"*. Disruptive factors, "Innovation Management Devils" is how he calls them, inhibit innovation behavior by delaying or converting it and therefore are considerable barriers. This could be also explained with what Goffin & Mitchell (Goffin ja Mitchell 2005) have realized "the challenges with managing innovation are compounded by the fact that many ideas that are effective in one organization cannot be easily transferred and must be adapted case by case".

General understanding is that *"innovation management is the key driver for sustainable growth and competitiveness"* (Imp3rove 2010). As supporting an evidence for that, numerous attempts by various institutions can be named who show an intention to develop an internationally recognized uniform framework for innovation management. In the Harvard Review 17 articles were publish in 2011 concerning innovation (Thuriaux-Alemán, Eagar ja Johansson 2013).

2.4 Overview of the documentation on innovation management

In the following section a comprehensive overview will be offered about the current state of documentation developed (and in development) on innovation management. Due to the

[12] Europe INNOVA program information http://www.innova-eu.net/publications/benchmarking-studies/13-benchmarking-studies/178-qexploratory-team-report-on-high-growth-innovative-smesq, accessed on the 6.05

difficulty in obtaining literature from all international sources, there may be some lack of relevant documentation from the wider field of innovation management.

See below Table 2 chronologic line of the innovation management documentation development influencing the economic area of the European Union. It includes the launch of first national standards, Oslo Manual updates and information on innovation management framework development process.

20th century timeline

1981	1991	1992	1992	1997
The Measurement of Scientific and Technological Activities, OECD, updated in 1994	French national standard FD X50-901 on project management and innovation	CEN-STAR committee was formed	OSLO Manual 1st version	OSLO Manual 2nd version

2000-2010 timeline

2002	2005	2006	2007	2008
Development of Spanish RDI standard family starts	OSLO Manual 3rd updated version	Spanish national UNE 166000 standard family was launched	Portugal national NP4457 standard family was launched, Technical Committee CT169	CEN/TC 389 "Innovation Management" Committee was created in November

2010 ongoing timeline

2011	2012	2012	2013	2013
French national standard FD X50 family was re-launched	ISO/TMB/NWIP Research, development and innovation – Process management proposal by ABNT (November)	ISO/TS/P 233 (identified as ISO/TC 279) Innovation process: interaction, tools and methods proposal by AFNOR (December)	ISO/TC 279 Innovation process: interaction, tools and methods approved and under development	CEN/TS 16555-1:2012 Innovation Management – Part 1: Innovation Management System has been approved by the beginning of June

Table 2. Chronologic line of the innovation management documentation.

2.4.1 Development of innovation management systems (IMS)

Mír and Casadesús (Mir e Casadesús 2011) agree that historical development of innovation management has passed five generations of innovation processes which were first mentioned by Rothwell in 1994. These generations are identified throughout a period of approximately fifty years starting from 1950s until 20th century and in the final fifth generation innovation is characterized as an essential contemporary business practice (Rothwell 1994). By which time a well-known linear model from Kline had also became successful.

In 1992 the European Committee for Standardisation action group dealing with Standardization and Research (CEN-STAR committee) was formed as innovation was considered as key objective to be integrated to R&D. Consequently, *CEN/TC 389 Innovation*

Management Committee[13] was created in November 2008 with an intention to support innovation culture in Europe and accelerate the access of innovation to both domestic and global markets. The committee is currently carrying out a work to provide organizations with tools, methods, approaches and processes that would facilitate their realization of innovation management. The draft version of standard Technical Specification *CEN/TS 16555-1 Innovation Management – Part 1: Innovation Management System* has been submitted for formal voting and was approved[14] by the end of May 2013. Other complementary documents such as innovation management assessment, creative thinking (see in the Table 3) are still under development.

Oslo Manual is developed by the OECD forum, where governments of 30 democracies uniquely work together to address the economic, social and environmental challenges of globalization. This forum aknowledges that over time the nature and landscape of innovation has been changing and conducted considerable research since the 1980s on models and analytical frameworks developed for the study of innovation. The need for a choherent set of concepts and tools led to the 1st edition of the Oslo Manual in 1992 (focused on technological product and process). Surveys based on the 1st version led to further refinements of the manual and the 2nd version published in 1997 included already existing service sectors. Ongoing surveys and changing policy needs have driven to the launching of what is known as the 3rd version where innovation has been expanded to adequately include innovation in the service sector by through inclusion of marketing and organizational innovation. (OECD and Eurostat 2005)

National standards are local initiatives developed by national certification bodies that seek to foster national innovation management practices. They are mainly voluntary nevertheless, can be interrelated to national policies and programs. In further sections is collaborated a more comprehensive overview of this topic.

By the end of 2012 there were two initiatives for developing an ISO international standard for innovation management, one proposed in November by a Brazilian national certifying body ABNT and in the following month by a French organisation AFNOR. It is understood the AFNOR proposal *ISO/TS/P 233* (identified as *ISO/TC 279*) *Innovation process: interaction, tools and methods* proposal for an international ISO standard has been approved by International Organization for Standardization and according to the ISO, standard on innovation management is under development.

2.4.2 International, regional and national regulations on innovation management

As it has been taking a long time to advance with an innovation management instrument on an European level, numerous countries have taken the initiative to develop a nationally binding standard, for example Spain, Portugal and France among them. For a better overview relevant to existing and under development regulations supporting the culture of innovation, both

[13] Information available at http://www.cen.eu/cen/Sectors/Sectors/Innovation/Pages/TC%20389.aspx, accessed on the 10.06.2013

[14] Information available at http://www.cen.eu/cen/Sectors/TechnicalCommitteesWorkshops/CENTechnicalCommittees/Pages/WP.aspx?param=671850&title=CEN/TC%20389, accessed on the 24.05.2013

working documents and standards either on international, regional and national level found are listed in the Table 3.

International			
ABNT, (07.11.2012)	ISO/TMB/NWIP Research, development and innovation – Process management	standard	under development
AFNOR (20.12.2012)	ISO/TS/P 223 Innovation process: interaction, tools and methods	standard	under development
European			
OECD and Eurostat	OSLO Manual 3rd updated version- 2005	Manual	In use
European Commission	CEN/TC 389 Innovation Management - 2008	Technical specification	
	CEN/TS 16555-1:2012 Innovation Management – Part 1: Innovation Management System	Technical specification	Approved
	prCEN/TS 16555-2 Innovation Management - Strategic Intelligence Management	Technical specification	Under drafting
	prCEN/TS 16555-3 Innovation Management - Innovation Thinking	Technical specification	Under drafting
	prCEN/TS 16555-4 Innovation Management - Intellectual Property Management	Technical specification	Under drafting
	prCEN/TS 16555-5 Innovation Management - Collaboration Management	Technical specification	Under drafting
	prCEN/TS 16555-6 Innovation Management - Creativity Management	Technical specification	Under drafting
	prCEN/TS 16555-*N/A* Innovation Management - Innovation Management Assessment	Technical specification	Under drafting
National			
Brazil	ABNT NBR 16500:2012 – Activities to Management of Research, Development and Innovation (R&D&I): Terminology	standard	In force
	ABNT NBR 16501:2011 – Guidance for Management Systems of Research, Development and Innovation (R&D&I)	standard	In force
	ABNT NBR 16502:2012 –Management of Research, Development and Innovation (R&D&I): Guidelines to Elaboration of R&D&I projects	standard	In force
Denmark	pDS (code not known) User-oriented innovation	N/A	Under development
France (cont.)	FD X50-052:2011 – Innovation Management – Strategic Intelligence Management	N/A	In force
	FD X50-146:2011 – Innovation Management- Intellectual Property Management	N/A	In force

Table 3. Documentation on fostering innovation management practices. (cont. 1/2)

National			
France (cont.)	prFD X50-271 – Guide in the Implementation of the Innovation Management	N/A	N/A
	prFD X50-272 – Guide to Implement Open Innovation	N/A	N/A
	prFD X50-273 – Guide to Integrate Sustainable Development in the Innovation Process	N/A	N/A
Germany	DIN 77100:2010 – Patent valuation – General Principles of Monetary Patent Valuation	N/A	In force
Ireland	NWA 1:2009 – Guide to good practice and product development processes	N/A	In force
Mexico	Name and code not known	N/A	Under development
Portugal	NP 4456:2007 – Management of Research, Development and Innovation (RDI): Terminology and definitions of RDI activities	standard	In force
	NP 4457:2007 – Management of Research, Development and Innovation (RDI): Management system requirements of RDI	standard	In force
	NP 4458:2007 – Management of Research, Development and Innovation (RDI): Requirements for a RDI project	standard	In force
	NP 4461:2007 Management of Research, Development and Innovation (RDI): Competence and assessment of RDI management system auditors and RDI project auditors	standard	In force
Spain	UNE 166000:2006 – Research, Development and Innovation (R&D&i) Management: Terminology and definitions	standard	In force
	UNE 166001:2006 – Research, Development and Innovation (R&D&i) Management: R&D&i project requirements	standard	In force
	UNE 166002:2006 – Research, Development and Innovation (R&D&i) Management: R&D&i Management System Requirements	standard	In force
	UNE 166006 EX:2006 – Research, Development and Innovation (R&D&i) Management: Technology Watch System	standard	In force
United Kingdom	BS 7802:1995 – Glossary of terms used in operational research	N/A	N/A
	BS 7000-1:2008 – Design management systems: Part 1: Guide to managing innovation	standard	In force

Table 3. Documentation on fostering innovation management practices. (cont. 2/2)

2.5 Benchmarking of the frameworks of innovation management

In the scope of this dissertation six actively practiced and internationally known conceptualized tools of innovation management were identified and examined (listed in the chronological order). Three representing an academic approach (two of which are standards): Keith Goffin & Rick Mitchell Innovation Pentathlon framework, Spanish linear Innovation Model and Portuguese chain-interactive Innovation Model. The remaining models were based on the consulting experience: A.T. Kearney House of Innovation, Accenture Performance Innovation Engine and Arthur D. Little´s Innovation Excellence Model. During the process of writing the dissertation the *CEN/TS 16555-1:2012 Innovation Management – Part 1: Innovation Management System* was partly made available by the European Commission and it was perceived important to include also this framework. All together seven frameworks are studied in the context of this dissertation (Table).

a. Keith Goffin & Rick Mitchell Innovation Pentathlon framework (2005)
b. A.T. Kearney House of Innovation (2006)
c. Spanish linear Innovation Model, UNE 166002:2006
d. Portuguese chain-interactive Innovation Model, NP4457:2007
e. Accenture Performance Innovation Engine (2010)
f. CEN-Committee 389 Innovation Management, Part 1: Innovation Management System, CEN/TS 16555-1:2012
g. Arthur D. Little´s Innovation Excellence Model (2013)

Framework	Publishing year	Source	Used contexts	Mainly based on	Authorities involved in the development
Innovation Pentathlon framework	2005	Book	Scientific; Consulting	Authors´ research; Casework	Cranfield School of Management
House of Innovation	2006	Working document	Consulting; IMP^{3}rove initiative	Casework	A.T. Kearney consulting
Innovation management Model – UNE 166002:2006	2006	Standard	Scientific; Certification	Kline and Rosenberg model	Spanish Ministry of Science and Education; universities, public bodies; AENOR
Innovation Model - NP 4457:2007	2007	Standard	Academic; Certification	OECD Oslo Manual; Kline and Rosenberg chain-linked model; UNE 166002	The Portuguese Standardization State Agency; Technical Committee CT 169; APCER; COTEC Portugal

Table 4. Characterization of the models included in the study[15]. (cont. 1/2)

[15] The ones marked with light blue are further involved in the auditing tools benchmarking.

Framework	Publishing year	Source	Used contexts	Mainly based on	Authorities involved in the development
Performance Innovation Engine	2010	Working document	Consulting	Casework	Accenture consulting
Innovation management model CEN/TS 16555-1:2012	2012	Technical Specification	Scientific; Consulting	National standardization bodies; scientific work	CEN-Committee 389
Innovation Excellence Model	2009/2010; 2013[16]	Working document	Consulting	Casework	Arthur D. Little consulting

Table 4. Characterization of the models included in the study[17]. (cont. 2/2)

Goffin & Mitchell in the book "*Innovation Management: Strategy and Implementation Using the Pentathlon Framework*" (2005) present techniques and examples of how to meet the challenge of developing and implementing an innovation strategy. Their approach to innovation management is scientifically recognized by the Cranfield School of Management. Currently the second edition is in progress, where the complexity of the interactions between the five building blocks assists organizations to draw more attention on recognizing opportunities. According to Pentathlon framework innovation management requires versatile skills from managers like the Olympic sport pentathlon. It very much underlines the importance of communication as part of the innovation management. (Goffin ja Mitchell 2005)

A.T. Kearney House of Innovation (2006) like the Pentathlon Framework is a reference model for the IMP^{3}rove initiative which with its aims focused on a holistic approach was in 2006 used to develop the future European innovation management standard. The initiative was directed to support the SMEs efforts to develop their innovation management capabilities. Despite of the continued effort, this initiative has been maintained on consulting level only and the originally planned reference document due by 2009 has not been published. (Imp3rove 2010)

The Spanish *UNE 166002:2006* standard was launched in 2006 after a successful trial period of four years by AENOR. Their academic approach to innovation process and its model is adapted from the Kline (1985) chain-linked model. (Asociación Española de Normalización y Certificación 2006)(Mir e Casadesús 2011). *UNE 166002:2006* is considered as one of the first national standards in Europe for innovation management.

The Portuguese *NP4457:2007* standard was developed based on the Spanish UNE family in 2007 with a wider perspective so it could be used by organizations of any kind as innovation

[16] Latest framework update.

[17] The ones marked with light blue are further involved in the auditing tools benchmarking.

in its concept is hosted in its broader sense. Innovation was considered in the industry sector as well as in services, and as much as in the traditional sectors also in the sophisticated sectors. (Instituto Português de Qualidade 2007b)

Accenture is global management consulting firm, and their *Performance Innovation Engine* developed tools to manage company innovation portfolios. The newly introduced innovation death spiral model helps to avoid creating a disruptive innovation cycle. Generally the framework aims to support successful innovation and it promotes Accenture consulting experience. (Koetzier, Kristensen ja Alon 2011)

Innovation Management – Part 1: Innovation Management System, CEN/TS 16555-1:2012 (2012) was developed by the CEN-Committee 389 as a Technical Specification to foster innovation management practices in European economical area. When writing this dissertation the specification is still under review and the author does not have access to the full version of the document.

Arthur D. Little´s *Innovation Excellence Model* was originally indroduced in 1995 and has been gradually refined through extensive casework. As a Pentathlon framework it provides a structure to demostrate the different components of the innovation system and indicates activities that companies can apply to achieve a better return on their investment in innovation management. (Thuriaux-Alemán, Eagar ja Johansson 2013)

2.5.1 Frameworks´ scope characteristics according to the model

All of the models (except the CEN/TS 16555-1:2012) have practical implementation information and therefore valuable knowledge can be obtained by studying them. Graphical views of the named innovation management tools present variety, nevertheless processes covered by the conceptualized tools in the study show high similarity. In the first column of Table 5 is indicated the framework name, in the second one its graphical design (in Appendix B can be found larger scale graphical views of all of them) and in the right column are described the RDI management characteristics visually identifiable in the models. In the brackets is indicated the number of questions/statements.

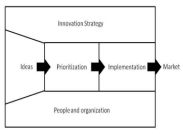
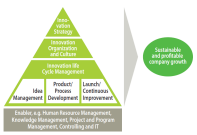
Framework	Graphical view	RDI management characteristics according to the model
Innovation Pentathlon framework (2005)		Innovation stategy; Ideas; Prioritization; Implementation; People and Organization.
House of Innovation (2006)		Innovation strategy; Innovation organizational and culture; Innovation life-cycle management (Idea management; Product/process development; Launch/ continuous Improvement); Innovation enablers (human resource management; knowledge management; project and program management; controller; IT); Innovation management success.

Table 5. Scope of each model. (cont. 1/3)

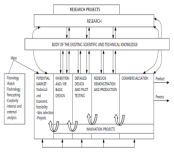
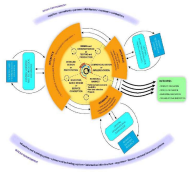
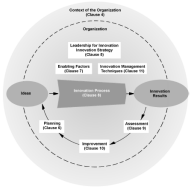
Framework	Graphical view	RDI management characteristics according to the model
Innovation Management Standard – UNE 166002:2006		Research projects, Research; Accumulation of existing scientific-technical knowledge; Ideas (Technology watch and foresight, Internal creativity, Analyses); Innovation projects; Potential market (Technical-economical viability, Selection of ideas, Projects); Invention and/or Basic design; Detailed design and Pilot testing; Redesign, Demonstration and Production; Marketing; Product, Process.
Innovation Management Standard - NP4457:2007		Potential market; Invention, basic design or Service conception; Detailed design or Prototyping; Design and Demonstration or Testing and Production; Commercialization or Implementation; Interfaces with existing Scientific and technological knowledge, Marketing knowledge, Organizational knowledge; Outcomes (Product, Process, Marketing, Organizational innovation); Results evaluation; Micro- environment (suppliers, consultants, partners, distributors, customers, competitors); Macro – environment (education and training system, science and technology system, information infrastructure, regulators, finance, sectoral innovation systems).
Performance Innovation Engine (2010)		Strategy; Manage Innovation; Discover (The Front-end of Innovation - "Do the Right Things"; Building Growth); Execute (The Centre of Innovation - "Do Things Right"; Driving Results); Commercialize (The Back-end of Innovation; Repeating Rewards); Innovation ROI; High Performance Innovation (Fast; Differentiated; Successful; Predictable; Efficient).
Innovation management model CEN/TS 16555-1:2012[18]		Context of the Organization; Organization; Leadership for Innovation, Innovation Strategy; Enabling factors; Innovation Management Techniques; Ideas; Innovation Process; Innovation Results; Assessment, Improvement, Planning.

Table 5. Scope of each model. (cont. 2/3)

[18] The author does not have access to the full version of the document.

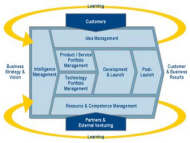
Framework	Graphical view	RDI management characteristics according to the model
Innovation Excellence Model (2013)		Company details and innovation performance; Innovation strategy; Business Intelligence; Idea Management; Product/ Service Portfolio Management; Technology Portfolio Management; Development & Launch; Post-Launch; Resource & Competence Management; Special focus on growth.

Table 5. Scope of each model[19]. (cont. 3/3)

Innovation Pentathlon framework in its model characteristics includes: i) innovation stategy, ii) ideas, iii) prioritization, iv) implementation and v) people and organization.

A.T. Kearney House of Innovation pyramid building blocks distinguish clearly: i) innovation strategy, ii) innovation organizational and culture, iii) innovation life-cycle management iii-a) idea management, iii-b) product/process development, iii-c) launch/ continuous improvement, iv) innovation enablers (human resource management, knowledge management, project and program management, controller, IT) and v) innovation management success.

In the Spanish linear Innovation Model RDI activities are characterized as: i-a) research projects, i-b) research; ii) accumulation of existing scientific-technical knowledge; iii) ideas, iii-a) technology watch and foresight, iii-b) internal creativity, iii-c) analyses; iv) innovation projects; v) potential market, v-a) technical-economical viability, v-b) selection of ideas, v-c) projects; vi) invention and/or basic design; vii) detailed design and pilot testing; viii) redesign, demonstration and production; ix) marketing and product, process.

RDI scope of the Portuguese chain-interactive Innovation Model includes: i) potential market; ii) invention, basic design or service conception; iii) detailed design or prototyping; iv) design and demonstration or testing and production; v) commercialization or implementation; vi) interfaces with existing scientific and technological knowledge, marketing knowledge, organizational knowledge; vi) outcomes (product, process, marketing, organizational innovation); vii) results evaluation; viii) micro- environment (suppliers, consultants, partners, distributors, customers, competitors) and ix) macro – environment (education and training system, science and technology system, information infrastructure, regulators, finance, sectoral innovation systems).

Accenture Performance Innovation in its engine characteristics include: i) strategy; ii) manage innovation; iii) discover (The Front-end of Innovation - “Do the Right Things”; building growth); iv) execute (The Centre of Innovation - “Do Things Right”; driving results); v) commercialize (The Back-end of Innovation; repeating rewards); vi) Innovation ROI and vii) High Performance Innovation (Fast; Differentiated; Successful; Predictable; Efficient).

Innovation Management, Part 1: Innovation Management System developed by CEN-Committee 389 includes: i) context of the organization; ii) organization; iii-a) leadership for innovation, iii-b) innovation strategy; iv) enabling factors; v) innovation management

[19] In Appendix B can be found larger scale graphical views of all the models.

techniques; vi) ideas; vii) innovation process; viii) innovation results; ix-a) assessment, ix-b) improvement and ix-c) planning.

Innovation Excellence Model shows similarity to Pentathlon framework in its building blocks: i) company details and innovation performance, ii) innovation strategy, iii) business intelligence, iv) idea management, v) product/ service portfolio management, vi) technology portfolio management, vii) development & launch, viii) post-launch, ix) resource & competence management, x) special focus on growth.

2.5.2 Outcome of the benchmarking of the frameworks

According to the models studied and innovation management literature reviewed the essential processes commonly related to innovation management were identified. As mentioned, despite most models being graphically quite different, similarity in their scope is considerable. Under the top management leadership lie i) *organizational strategy for innovation* and ii) *organizational culture*. Innovation management operational activities in this benchmarking are considered iii) *management of knowledge*, iv) *creation and management of ideas* and v) *management technology and projects*. *Development of new products/services* (vi) and their vii) *commercialization and diffusion of the products/services* steps are likewise in one or another way present in all the frameworks and more, viii) *management of already launched products* was considered relevant to include. *Uniqueness* (ix) category was added to give importance to some of the frameworks´ characteristics not revealing in the previous points.

In detail benchmarking of these nine processes/categories were applied to assist in the comparison of the various frameworks´ scope and can be found in the left hand of the Table 6. On the top of the table frameworks are presented in chronological order from the left to the right. In the columns below are identified the matching characteristics according to the model analysed in the previous Table 5 and in the joint section their similarities and differences are briefly described. In the tables joint section comments are given only in relation to the visual aspects of the frameworks´ models.

Higher conformity can be found in management of knowledge, creation and management of ideas, in development and commercialization categories. Other categories, organizational strategy for innovation, organizational culture, management of technology projects, management of already launched projects and uniqueness present 3-5 frameworks including information on them.

In the paragraphs following the table each of categories are presented. Information is mostly equivalent to the joint section of the table. When substantial then in the paragraphs is also included information from the according written documentations.

2.5.2.1 Organizational strategy for innovation

Analogy revealed between the frameworks as almost all their visuals are clearly identifying organizational strategy for innovation (except the Spanish and Portuguese standard models). Moreover, in the Pentathlon framework it s expected to consist of strategic i) analyses, ii) choice and iii) implementation. For House of innovation the innovation strategy is located on top of the pyramid, whereas Performance Engine *manage innovation* is perceived to involve all the respective activities related to innovation management. In Excellence Model organizational innovation strategy includes corporate strategic and innovation priorities.

Nevertheless of not having a visual component, in the Spanish and Portuguese standards´ specifications it emphasised the commitment and responsibility of top management and RDI policy.

2.5.2.2 Organizational culture

Organisational culture is clearly identified in the Pentathlon framework, House of innovation, Portuguese standard and CEN/TS innovation management model. According to Pentathlon framework organizational culture is considered as the foundation stone of innovation. Moreover, in the House of innovation pyramid structure the cultural component positions penultimate building block when starting from the top. Organizational culture component is present in the Spanish standard specification, where it is referred to work environment nevertheless there is no building block in the visual model.

Processes covered by innovation management tools identified	Innovation Pentathlon framework	House of innovation	Innovation Management Standard – UNE 166002:2006	Innovation Management Standard - NP4457:2007	Performance Innovation Engine	Innovation management model CEN/TS 16555-1:2012	Innovation Excellence Model
Organisational strategy for innovation	Innovation strategy	Innovation strategy	-	-	Strategy; Manage innovation	Innovation strategy; Leadership for innovation	Innovation strategy; Company details and innovation performance
	Visuals from the frameworks have clear specification of organizational strategy for innovation (except the Spanish and Portuguese standard models). In the Pentathlon framework it s expected to consist of strategic i) analyses, ii) choice and iii) implementation. For House of innovation the innovation strategy is located on top of the pyramid, whereas Performance Engine *manage innovation* is perceived to involve all the respective activities related to innovation management. In Excellence Model it includes corporate strategic and innovation priorities.						
Organisational culture	People and organization	Innovation organizational and culture	-	Outcomes (Organizational innovation)	-	Context of the Organization	-
	Organisational culture is clearly identified in the Pentathlon framework, House of innovation, Portuguese standard and CEN/TS innovation management model. According to Pentathlon framework organizational culture is considered as the foundation stone to innovation. In the house of innovation pyramid the cultural component positions penultimate building block from the top.						
Management of knowledge	People and Organization	Innovation enablers (knowledge management)	Accumulation of existing scientific-technical knowledge	Interface with organizataional knowledge (knowledge management); Macro environment (education and training system)	Manage innovation	Enabling factors; Innovation management techniques	Resource & Competence Management
	Management of knowledge is represented with a visual identification in all of the analysed frameworks. According to Pentathlon framework managing knowledge is covered by *people and organization* including Training, Recruitment, Manpower plans and Processes. For Performance Engine *manage innovation* is perceived to cover also knowledge management.						

Table 6. Benchmarking of the frameworks. (cont. 1/4)

Processes covered by innovation management tools identified	Innovation Pentathlon framework	House of innovation	Innovation Management Standard – UNE 166002:2006	Innovation Management Standard - NP4457:2007	Performance Innovation Engine	Innovation management model CEN/TS 16555-1:2012	Innovation Excellence Model
Creation and management of ideas	Ideas	Idea management	Invention and/or Basic design; Ideas	Invention, Basic design or Service conception	Discover	Ideas	Idea management
	Idea creation as the first phase of innovation process, sometimes also identified as Schumpeter named it discovery or invention, is well-covered in all the frameworks. Goffin and Mitchell explain that *ideas* mainly consist of targets managing creativity and knowledge and there are many techniques to boost creative ideas. For A.T. Kearney *idea management* is a corner block of the pyramid essential baseline innovation *life-cycle management*. For the Spanish standard *ideas* are expressed via technology watch and foresight, internal creativity, analyses and potential market. According to the Portuguese standard specifications *invention* involves idea management and evaluation of opportunities. For Accenture consulting *discover* means "do the right things" and is the front-end of innovation where growth is built. According to Arthur D. Little, *idea management* is the process to generate and manage ideas for new products/services.						
Development of new products/ services/processes	Prioritization; Implementation	Product/process development	Detailed design and Pilot testing	Detailed design or Prototyping	Execute	Innovation process (Assessment, Improvement, Planning)	Development and launch
	Either called prioritization or innovation process, here the ideas are converted into new products/services/processes, all the frameworks contain this phase. In the Penthathlon framework *prioritization* is the selection and managing the portfolio. According to A.T. Kearney *product/process development* is the middle building block of the pyramid baseline. In the both standards´ *detailed design* indication is allocated to match the new product development needs. According to Performance Engine *execute* helps to drive an idea or briefing to the market launch and itself means "do things right" and is the centre of innovation. For Excellence Model *development and launch* are all steps required to transform the original idea into a launched product/service/process.						

Table 6. Benchmarking of the frameworks. (cont.2/4)

Processes covered by innovation management tools identified	Innovation Pentathlon framework	House of innovation	Innovation Management Standard – UNE 166002:2006	Innovation Management Standard - NP4457:2007	Performance Innovation Engine	Innovation management model CEN/TS 16555-1:2012	Innovation Excellence Model
Management of technology and projects	Prioritization	Innovation life-cycle management	-	-	The centre of innovation	Innovation management techniques	Product/ Service Portfolio Management; Technology portfolio management
	Management of technology projects is well-covered by most of the frameworks (except Spanish and Portuguese standard). According to Pentathlon framework prioritization connected to technology and project management includes strategic allocation, roadmaps, risk-reward balance and metrics. In the House of innovation it is perceived to be covered by the innovation life-cycle management. Accenture framework includes an interlinked building block called *the centre of innovation* and in the CEN/TS *innovation management techniques* are identified on the organizational level. According to the A.D. Little there are two closely related units, i) *product/ service portfolio management* and ii) *technology portfolio management*.						
Commercialisation and diffusion of the products/services	Implementation	Launch/ continuous Improvement	Redesign, Demonstration and Production; Marketing	Design and Demonstration or Testing and Production; Commercialization or Implementation	Commercialize	Innovation results	Development and launch
	Present in all the models, can be verified that commercial component becomes more obvious from the practices directly applied in the business use. According to the Pentathlon framework *implementation* is realised throughout four phases of project management: i) concept, ii) design, iii) planning, iv) implementation itself. In the Performance Engine c*ommercialize* is identified as a mean to repeat rewards in the scope of back-end of innovation.						

Table 6. Benchmarking of the frameworks. (cont.3/4)

Processes covered by innovation management tools identified	Innovation Pentathlon framework	House of innovation	Innovation Management Standard – UNE 166002:2006	Innovation Management Standard - NP4457:2007	Performance Innovation Engine	Innovation management model CEN/TS 16555-1:2012	Innovation Excellence Model
Management of already launched products	-	Launch/continuous improvement	-	Results evaluation	-	-	Post-Launch
	Management of already launched products is seldom present in the frameworks; nevertheless product upgrading and continuous improvement could be seen as an input for new ideas.						
Uniqueness	-	-	Designed by analogy with ISO 9001 and 14001 standards	Compatibility to ISO 9001 and 14001 standards	Addresses frequency, speed and consistency of innovation results	-	Special focus on growth
	Both of the standards are developed according to the ISO international standard principles to facilitate their co-implementation and integration with other management systems. Consulting frameworks from Accenture and A.D. Little pay attention to innovation outcomes.						

Table 6. Benchmarking of the frameworks. (cont. 4/4)

2.5.2.3 Management of knowledge

Importantly, management of knowledge is represented with a visual identification in all of the analysed frameworks. According to Pentathlon framework managing knowledge is covered by *people and organization* including Training, Recruitment, Manpower plans and Processes. For Performance Engine *manage innovation* is possibly perceived to cover also knowledge management. When we look into standards´ specifications both include *competence, awareness and training*, whereas Spanish standard includes moreover *resource management*.

2.5.2.4 Creation and management of ideas

Idea creation is commonly considered as the first phase of innovation process and sometimes as also described in the innovation management system part under literature review of this dissertation identified as Schumpeter named it discovery or invention. This process is well-covered in all the frameworks. Goffin and Mitchell explain that *ideas* mainly consist of targets managing creativity and knowledge and there are many techniques to boost creative ideas. For A.T. Kearney *idea management* is a corner block of the pyramid essential baseline innovation *life-cycle management*. For the Spanish standard *ideas* are expressed via technology watch and foresight, internal creativity, analyses and potential market. According to the Portuguese standard specifications *invention* involves idea management and evaluation of opportunities. For Accenture consulting *discover* means "do the right things" and is the front-end of innovation where growth is built. According to Arthur D. Little, *idea management* is the process to generate and manage ideas for new products/services.

2.5.2.5 Development of new products/services/processes

Either called prioritization or innovation process, here the ideas are converted into new products/services/processes and are further developed. All the frameworks contain this phase. In the Penthathlon framework *prioritization* is the selection and managing the portfolio. According to A.T. Kearney *product/process development* is the middle building block of the pyramid baseline. In the both standards´ *detailed design* indication is allocated to match the new product development needs. According to Performance Engine *execute* helps to drive an idea or briefing to the market launch and itself means "do things right" and generally belongs to the centre of innovation. For Excellence Model *development and launch* are steps identified and required to transform the original ideas into ready to launch product/service/process.

2.5.2.6 Management of technology and projects

Management of technology projects is well-covered by most of the frameworks (except Spanish and Portuguese standard). According to Pentathlon framework prioritization is connected to technology and project management and includes strategic allocation, roadmaps, risk-reward balance and metrics. In the House of innovation management of technology and projects can be perceived to be covered by the innovation life-cycle management. Accenture framework includes an interlinked building block called *the centre of innovation* and in the CEN/TS *innovation management techniques* are identified on the organizational level. According to the A.D. Little there are two closely related units, i) *product/ service portfolio management* and ii) *technology portfolio management*. Spanish standard specification includes planning, monitoring and control of project portfolio.

2.5.2.7 Commercialisation and diffusion of the products/services

Commercialization and diffusion of the products/services is found present in all the models. Moreover, can be verified that commercial component becomes more obvious from the frameworks directly applied in the business use. According to the Pentathlon framework *implementation* is realised throughout four phases of project management: i) concept, ii) design, iii) planning, iv) implementation itself. In the Portuguese standard specifications there is a point referring to implementation and operations. In the Performance Engine c*ommercialize* is identified in the back-end of innovation as a mean to repeat rewards.

2.5.2.8 Management of already launched products

Pos-launch is seldom present in the frameworks; nevertheless product upgrading and continuous improvement could be seen as a favourable input for new ideas.

2.5.2.9 Uniqueness

Both of the standards are developed according to the ISO international standard principles to facilitate their co-implementation and integration with other management systems either standardized or not. Consulting based frameworks from Accenture and A.D. Little pay compared to other benchmarked frameworks more attention to innovation outcomes.

2.6 Scope of the frameworks´ auditing tools

As for elaborating the case study in the scope of this dissertation, the methodology anticipates conducting interviews, and therefore a questionnaire for that aim was designed based on the frameworks in the study. For that purpose three frameworks with different background (colored light blue in the Table 4) i) Pentathlon framework with academic background, ii) Portuguese RDI management standard and iii) Innovation Excellence Model based on the casework, were identified and accordingly their auditing tools were benchmarked. Portuguese standard NP4457:2007 has no official auditing guide available but related Innovation Scoring framework developed together with the standard family was used.

Auditing documentation specifications are presented in the following Table 7, where in the left column is indicated the auditing framework, in the middle one the auditing building block type and in the right one is named the building block scope. In the brackets is indicated the number of questions/statements. This information is sourced from the respective auditing documentation.

Auditing framework	Auditing builidng blocks	Building block scope
Innovation Pentathlon framework Audit Questions (2005) (cont.)	General data (4)	(4)
	Innovation strategy (60)	Management leadership (11) Market and competior analyses (11) Funding of innovation (8) Innovation performance measures (4) Innovation performance (results) (3) Innovation networking (8) Technology management (11) Market planning and review (4)

Table 7. Scope of the frameworks´ auditing tools. (cont. 1/3)

Auditing framework	Auditing builidng blocks	Building block scope
Innovation Pentathlon framework Audit Questions (2005) (cont.)	Ideas: managing creativity and knowledge (40)	Culture of creativity and innovation (13) Use of creativity tools, approaches (5) Knowledge management (10) Use of enchanced market reseach methods (9) Creativity levels in the organization (3)
	Prioritization: selecting & managing the portofolio (26)	Prioritization process (13) Analyses tools and approache (6) Current portfolio (7)
	Implementation (85)	The management process (12) Structure and organisation (5+5) Industrial design (4) Transfer to operations (5+1) Market and distribuition (17) Promotional mix (6) Tools for innovation (6) Process innovation (24)
	People and organization (49)	Innovation culture (20) Recruting and job assignment (10) Managing performance (2+2) Development of emplyees (10) Organizational structure (5)
Innovation Scoring (2008) Related to NP4457:2007	Organization characterization (37)	Information (1) General data (25) Collaborators (2) Certifications (4) Financial (2) Research, development and innovations (3)
	Conditions (12)	Culture (4) Leadership (4) Strategy (4)
	Resources (13)	Human capital (3) Competences (5) External relations (2) Structures (3)
	Processes (11)	Management of RDI activities (7) Systematic learning and improvement (3) Protection and assessment of results (1)
	Results (8)	Financial and operational (2) Market (4) Society (2)
Innovation Excellence Survey (2012) (cont.)	Company details and innovation performance (36)	Industry sector (21) Company characteristics (4) Investment to innovation activities (2) Overall innovation capabilities (9)
	Corporate strategic & innovation priorities (Innovation strategy) (11)	Innovation effort (3) Approach to meeting growth (4) Innovation strategy integration (4)
	Business Intelligence (8)	Process and responsibilities (4) Participants and sources (2) Customer segmentation (1) Tools (1)
	Idea Management (16)	Process and responsibilities (4) Usage of guidelines and insights (2) Participants and sources (5) Tools (5)

Table 7. Scope of the frameworks´ auditing tools. (cont. 2/3)

Auditing framework	Auditing builidng blocks	Building block scope
Innovation Excellence Survey (2012) (cont.)	Product/ Service Portfolio Management (6)	Product and service portfolio and evaluation (6)
	Technology Portfolio Management (6)	Technology strategy (3) Technology portfolio (3)
	Development & Launch (16)	Product/service/process development (12) Process and responsibilities (4)
	Post-Launch (7)	(7)
	Resource & Competence Management (6)	(6)
	Special focus on growth (11)	Strategy (1) Finding growth (5) Delivering growth (5)

Table 7. Scope of the frameworks´ auditing tools. (cont.3/3)

Innovation Pentathlon framework innovation audit questions follow the identical building block structure as the framework´s model and include all together 264 question. Innovation Scoring 81 questions cover i) organization characterization, ii) conditions, iii) resources, iv) processes and v) results. And lastly, Innovation Excellence survey embraces the building block structure as identified in the framework characterization scope by identifying 123 of questions and statements.

2.6.1 Outcomes of the benchmarking of the auditing tools

The structure used for auditing benchmarking was maintained very similar to the benchmarking of the frameworks presented earlier. Main structural differences originating from the above Table 7 were the addition as the first category *company characterization* and as the last *innovation outcome*. *Development of new products/ services/processes* and *management of technology and projects* were joined as their statements made sense to be presented jointly, *uniqueness* did not find coverage and therefore was not included.

Overall, nine categories were analysed and can be found in the left side of the Table 8. On the top line of the table auditing tools are presented in chronological order. In the columns below are identified the matching auditing building blocks, below that the according building block scope that comes from the right hand column of the Table 6. Benchmarking of the frameworks. In the joint section auditing tools similarities and differences are shortly described and topics included in the questionnaire are highlighted. In the brackets following the auditing scope is when possible indicated a number which refers to quantity of questions/statements related to that point.

Results from these benchmarking observations were applied to design the questionnaire used to obtain empirical data presented in the future sections of this dissertation.

The available three auditing schemes show conformity in company characterization, organizational strategy for innovation, management of knowledge, creation and management of ideas and in development of products/services and management of technology and projects. Organizational culture, commercialization and diffusion of the products/services,

management of already launched projects and innovation outcome are covered either by two or only one auditing tool.

Processes covered by innovation management auditing tools	Innovation Pentathlon framework Innovation Audit Questions (2005)	Innovation Scoring (2008) Related to NP4457:2007	Innovation Excellence Survey (2012)
Organisation characterization	General data	Organization characterization	Company details and innovation performance; Corporate strategic & innovation priorities
	(4) *not much covered	Information (1) General data (25) Collaborators (2) Certifications (4) Financial (2) Research, development and innovations (3)	Industry sector (21) Company characteristics (4) Investment to innovation activities (2) Overall innovation capabilities (9)
	In auditing company characterization is generally included in order to provide the first approach and boundaries of the organization/company in study. <u>Covered topics:</u> • General data about the company • Financial data about the company • Implemented management systems • Company innovation behaviour (innovation adoption, type of innovation, degree of innovation)		
Organisational strategy for innovation	Innovation strategy; People and organization	Conditions	Corporate strategic & innovation priorities; Business Intelligence; Special focus on growth;
	Management leadership (11) Market and competior analyses (11) Funding of innovation (8) Innovation performance measures (4) Innovation performance (results) (3) Innovation networking (8) Technology management (11) Market planning and review (4) Innovation culture (20)	Strategy (4)	Innovation effort (3) Approach to meeting growth (4) Innovation strategy integration (4) Process and responsibilities (4) Participants and sources (2) Customer segmentation (1) Tools (1) Strategy (1)
	Innovation strategy is addressed significance as within the management systems is perceived important the top management commitment in order to obtain successful results. <u>Covered topics:</u> • Understanding about the concept of innovation • Development of a systematised innovation management system • Motivation for developing an innovation management system • Innovation strategy statements		

Table 8. Benchmarking of the auditing tools. (cont. 1/3)

Processes covered by innovation management auditing tools	Innovation Pentathlon framework Innovation Audit Questions (2005)	Innovation Scoring (2008) Related to NP4457:2007	Innovation Excellence Survey (2012)
Organisational culture	People and organization	Conditions	-
	Innovation culture (20) Recruting and job assignment (10) Managing performance (2+2) Development of emplyees (10) Organizational structure (5)	Culture (4) Leadership (4)	
	Organizational innovation culture gives insights about the organization practices that foster a supportive environment for value creation. In the Excellence survey it is not covered directly. Covered topic: • Innovation culture statements		
Management of knowledge	People and organization	Resources	Resource & Competence Management
	Recruting and job assignment (10) Managing performance (2+2) Development of emplyees (10) Organizational structure (5)	Human capital (3) Competences (5) External relations (2) Structures (3)	(6)
	Knowledge management is about mapping the organizational current and future competence needs both internally and externally. Covered topics: • Knowledge management statements • Employee training statements		
Creation and management of ideas	Ideas: managing creativity and knowledge	Processes	Idea management
	Culture of creativity and innovation (13) Use of creativity tools, approaches (5) Knowledge management (10) Use of enchanced market reseach methods (9) Creativity levels in the organization (3)	Management of RDI activities (7) Systematic learning and improvement (3) Protection and assessment of results (1)	Process and responsibilities (4) Usage of guidelines and insights (2) Participants and sources (5) Tools (5)
	Creation and management of ideas as the origin of innovation are every time more given a systematized approach, dedication and importance. Covered topics: • Idea creation statements • Idea management and evaluation statements		

Table 8. Benchmarking of the auditing tools. (cont. 2/3)

Processes covered by innovation management auditing tools	Innovation Pentathlon framework Innovation Audit Questions (2005)	Innovation Scoring (2008) Related to NP4457:2007	Innovation Excellence Survey (2012)
Development of new products/ services/processes and Management of technology and projects	Prioritization: selecting & managing the portofolio; Implementation	Processes	Development & Launch Product/ Service Portfolio Management; Technology portfolio management
	Prioritization process (13) Analyses tools and approache (6) Current portfolio (7) The management process (12) Structure and organisation (5+5) Industrial design (4) Transfer to operations (5+1) Market and distribuition (17) Promotional mix (6) Tools for innovation (6) Process innovation (24)	Management of RDI activities (7)	Product/service/process development (12) Process and responsibilities (4) Product and service portfolio and evaluation (6) Technology strategy (3) Technology portfolio (3)
	New product development, management of technology and projects is covered by all the auditing tools as it is considered the hearth of a business success. Covered topic: • Development process statements		
Commercialisation and diffusion of the products/services	Implementation	Processes	
	The management process (12) Structure and organisation (5+5) Industrial design (4) Transfer to operations (5+1) Market and distribuition (17) Promotional mix (6) Tools for innovation (6) Process innovation (24)	Management of RDI activities (7)	
	Commercial coverage is mostly overviewed in the Pentathlon framework auditing. Covered topic: • Commercialization and marketing statements		
Management of already launched products	-	-	Post-Launch
			(7)
	Management of pos-launch activities is covered by the Excellence survey. Covered topic: • Pos-launch statements		
Innovation outcome	-	Results	Post-Launch
		Financial and operational (2) Market (4) Society (2)	(7)
	Innovation outcome is emphasised both in the Innovation Scoring and Excellence survey. Covered topic: • Innovation outcome statements		

Table 8. Benchmarking of the auditing tools. (cont. 3/3)

2.6.1.1 Company characterization

In auditing company characterization is generally included in order to provide the first approach and boundaries of the organization/company in study. Topics found relevant to category are: general data about the company; financial data about the company; implemented management systems; company innovation behaviour including innovation adoption, type of innovation, and degree of innovation.

2.6.1.2 Organizational strategy for innovation

Innovation strategy is addressed significance because for obtaining successful results from whatsoever management systems the top management needs to be committed to it. Topics found relevant are: understanding about the concept of innovation; development of a systematised innovation management system; motivation for developing an innovation management system and innovation strategy statements in general.

2.6.1.3 Organizational culture

Organizational innovation culture gives insights about the organization practices that foster a supportive environment for value creation. In the Excellence survey it is not covered directly. Here innovation culture statements cover the category relevance.

2.6.1.4 Management of knowledge

Knowledge management is about mapping the organizational current and future competence needs both internally and externally. Topics found relevant are: knowledge management and employee training.

2.6.1.5 Creation and management of ideas

Creation and management of ideas as the origin of innovation are every time more given a systematized approach, dedication and importance. Topics found relevant are: idea creation plus idea management and evaluation.

2.6.1.6 Development of products/services and management of technology and projects

New product development, management of technology and projects is covered by all the auditing tools as it is considered the hearth of a business success. Relevance is given to the development process topic by covering it with numerous statements.

2.6.1.7 Commercialisation and diffusion of the products/services

Commercial coverage of the innovation is mostly overviewed in the Pentathlon framework auditing scheme. Commercialization and marketing activities are examined.

2.6.1.8 Management of already launched products

Management of pos-launch activities is only covered by the Excellence survey.

2.6.1.9 Innovation outcome

Innovation outcome is emphasised both in the Innovation Scoring and Excellence survey.

3 Fostering innovation practices based on a standard

While authors discuss about the advantages and disadvantages about establishing standards for RDI system certification, since the 90s, nevertheless of the adverse opinions, practical approach of this convergence has undergone expansion in many developed countries.

European countries where a national standard for innovation management has been implemented are France, Portugal, Spain and United Kingdom. In the United Kingdom there is one reference standard *BS 7000-1:2008*, whereas in French *FD X50-271*, Portuguese *NP4457:2007* and Spanish *UNE 166002:2006* there are sets of frameworks included in the standard family. All related (families) of innovation standards can be found in the Table 3. Documentation on fostering innovation management practices. As far as known, all of the named standards are voluntary in their use.

France was the first country to develop a normative document on project management and innovation as early as 1991. Developing further standards took some years and only after the publishing of the OECD Oslo Manual, were Spanish and Portuguese national standard families for RDI management were developed and launched respectively in 2006 and in 2007. During the following years more countries, such as Germany, Ireland and in the United Kingdom developed reference documents related to culture of innovation. In 2011 the updated French RDI standard family was introduced.

The core focus in this work is to analyse the implementation advantages and disadvantages of the Portuguese standard NP4457:2007, therefore next paragraphs give overview of the standard development and adoption.

3.1 Development and characteristics of the NP4457:2007 standard

The Portuguese standard was developed in the scope of enterprise initiative Desenvolvimento Sustentado da Inovação Empresarial (DSIE)[20] by COTEC Portugal - Associação Empresarial para a Inovação[21]. "*Innovate means to create value in the change context*", has said the coordinator of DSIE João Bento. "*To be innovative companies do not necessarily need to innovate something new*" he commented by explaining that only inventing is not enough, value needs to be created. Organization plays a crucial role in introducing the Portuguese standard of RDI management system. Initiative contemplated four projects[22]: first of them identify and study the models and mechanisms for Sustained Development of Innovation and develop the chain-interactive Innovation Model, second defining a methodology for classifying RDI activities, third certificate the RDI management and fourth develop system for Innovation Scoring. Technical Committee CT169 was formed by the Portuguese Institute for Quality (IPQ) that designed and launched the national family of innovation standards. With a systematic approach, DSIE initiative continuously aims to encourage and support Portuguese companies in implementing innovation management systems for strengthening their competitive advantage in the growing global knowledge based economics. The process of developing the standardized framework and according mechanisms for fostering value creation started in 2006. (Pimental 2010)

[20] DSIE stands for Sustained Development of Company Innovation
[21] COTEC is a Business Association for Innovation, available at www.cotecportugal.pt
[22] Information available at the COTEC site.

The conceptual model of the Portuguese RDI standard family was strongly influenced by the OECD Oslo Manual third updated version from 2005. Innovation concept was constructed in the Portuguese RDI standard concept according to the Oslo Manual and therefore considered in the industry sector as well as in services and as much as within the traditional sectors as in the sophisticated sectors. Moreover, this concept was validated by 10 pilot companies from different activity sectors. The standard was developed with a wide perspective to permit its utility by organizations of any kind as innovation was fostered in its broadest sense. Four types of innovations were identified and considered relevant to the standard to help to convey the broader sense: product (good or service), process, and as it stands in the Oslo Manual, also organizational and marketing innovation were introduced. (Instituto Português de Qualidade 2007b)

The standard family objective was to establish a normative framework that would contribute to better performance of the organization using a RDI management method to foster knowledge and help transform the economic and social wealth of the company. Intentionally, to facilitate the implementation of NP4457:2007 accordance RDI management system, it was structured following the international management systems principle PDCA approach (Plan-Do-Check-Act), such as the other ISO standards. (Instituto Português de Qualidade 2007b)

3.1.1 The definition of innovation

According to *NP 4456:2007 Management of Research, Development and Innovation (RDI), terminology and definitions of RDI activities* innovation is defined as "the implementation of a new and significantly improved solution for a firm, a new product, process, organizational or marketing method, with the aim of reinforcing the firm´s competitive standing, improving its performance of its know-how". (Instituto Português de Qualidade 2007a)

3.1.2 The main innovation processes

Chain-interactive innovation model[23] was the reference model for the Portuguese standard that was developed by an expert group under COTEC. Its building blocks were previously described in the Table 5 and larger visual can be found in the Appendix B. For facilitating understanding, some information is repeated here. RDI scope consist of eight main building blocks including market insights, the invention with basic design or service conception, followed by more detailed design or even prototyping. Further design, testing and production continue by commercialization process. The model embodies three interfaces for an open innovation environment: existing scientific and technological knowledge, existing organizational knowledge and existing marketing knowledge. It is interesting to note that these named interfaces define the competence boundaries where the productive economic knowledge moves and is transferred between the innovative activity and its environment. In the model there are located outcomes, micro- environment and macro – environment with their according specifications.

[23] In the development of the chain-linked interaction model for innovation in the knowledge-based economy was used external help from area specialists, COTEC expert group was formed by J. Caraça, J. Ferreira and S. Mendonça. Report was published in October 2006

3.2 Implementation overview of the NP4457:2007

In Portugal, Research, Development and Innovation (RDI) standard family, among it the *NP4457:2007 Management of Research, Development and Innovation, RDI management system requirements* were developed by 2007 and in the end of 2011 being five years in force, already 102 companies were *NP4457:2007* certified[24]. In the Figure 1 they are presented by yearly certification number and overall tendency can be seen.

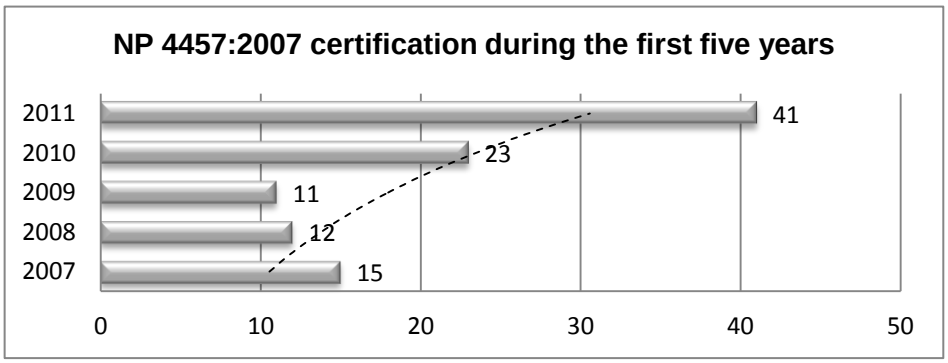


Figure 1. Portuguese RDI management standard NP4457:2007 certification during the first five.

By March 2013 all together 141 companies[25] had adopted the RDI management standard. Compared to other known standards in Portugal innovation management standard implementation has been showing a similar trend as ISO 14001:2004 environmental management system and OHSAS 18001:2007 safety management system adoptions (Caetano ja dos Guimarães Sá 2011).

According to sectoral analyses[26] standard adhere so far reveals that information technology (IT) sector with 34 certified companies is responsible for almost one fourth of the adoptions, see Figure 2. Other important sector among the certified companies is the aeronautics with 25 certified companies. Relevant are moreover electrical equipment production, construction and architectural engineering sector all equally with eight companies certified. Appendix C table of NP4457:2007 RDI scope certifications.

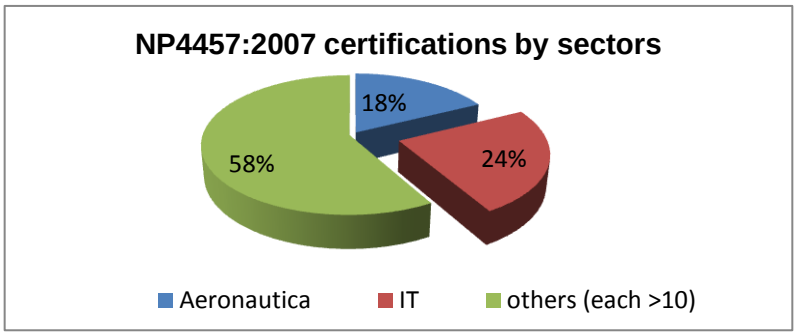


Figure 2. NP4457:2007 certifications by sector.

[24] Information found by COTEC site and sent by Isabel Caetano from COTEC.

[25]Information (last update done on the site on 1st of March 2012) retrieved from the IPAC site http://www.ipac.pt/pesquisa/pesq_empcertif.asp on 15.08.2013.

[26]Sectoral analyse information including the 141 companies is based on the certification scope and originates also from IPAC site where all together 80 categories for sectors are identified. http://www.ipac.pt/pesquisa/pesq_empcertif.asp (15.08.2013)

In the case of NP4557:2007, however it is a voluntary national standard, its implementation and certification has been applied as eligibility requirement in some Portuguse public incentive[27] contractual conditions. This will further be analysed in the case study.

3.2.1 24 pioneer companies to implement the NP4457:2007

COTEC has published in 2010 a document Guia de Boas Practicas de Gestão de Inovação [28] including 24 pioneer companies who have implemented the NP4457:2007 national voluntary standard. This manual was created to demonstrate the benefits that implementing this standard would bring to the company.

Generally the feedback from the 24 companies reveals that standard adoption is mostly related to a need of structuring better the organizational activities related to management of innovation inside the company and boosting competitiveness in the globalizing market condition. They say that the main system advantage is the establishment of favorable conditions that support the decision making by introduction of the indicators and methods of accompaniment which force the global management capacity with a systematic approach.

[27] *Company Investment Incentive Systems 2007-2013* under Quadro de Referência Estratégico Nacional (QREN) *National Strategic Reference Framework.*
[28] Guide of Best Practices for Innovation Management

4 Scope of this research

This dissertation endeavours to contribute to what is still uncertain about the relationship between innovation management standardized frameworks and companies innovation performance. It seeks to contribute to the empirical lagoon about the implementation impacts of the currently developed and applied standardized innovation management frameworks based on the Portuguese national RDI management standard NP4457:2007 application.

To answer the question of whether company performance is boosted or hindered by a standardized innovation management framework the implementation impact of the innovation management system in Portugal was examined from the perspective of trying to indicate the values or disadvantages the national standardized innovation management framework NP4457:2007 brings to the companies.

The aim of the empirical research conducted in the scope of this dissertation is to answer two questions. Firstly, what the advantages of implementing a RDI management based on a certified system are. And secondly, what is the implementation impact of a certified innovation management system based on the Portuguese sample.

Portugal is one of the few countries where there has been developed and implemented an innovation management standard since 2007, very valuable research can be conducted based on the Portuguese sample. There is little research on the implementation impact of the innovation management system in Portugal and therefore it is intriguing to investigate this topic on the doorstep of expansion of ISO standardization to innovation management.

4.1 Methodology used for case study

In order to examine innovation system adoption advantageousness based on the Portuguese example, a case study was carried out in order to obtain empirical data.

Qualitative data was favoured in order to give more insight to the implementation impact and therefore personal interviews were conducted. The case study sample included both the national standard NP4457:2007 certified companies and standard not implemented companies in different business developments and company size.

All together nine mainly Portuguese origin companies were interviewed to obtain the required data input for the empirical research of this dissertation; many of them with subsidiaries and/or international commitment.

The information technology (IT) sector was chosen because previous studies revealed that this sector has the highest standard NP4457:2007 adoption rate and importantly the author of this dissertation originates from Estonia where the IT sector is considered to be one of the backbones of the new epoch of economical development after re-gaining independence in 1991. Significantly, according to the Global Information Technology Report 2012 including 142 economies it is estimated that the information and communication technologies (ICT) industry contributes 25 percent of the European Union’s growth in GDP and 40 percent of its productivity growth. Even more, the emergence of new industries during the era of hyper connectivity is seen to be closely linked to continued economic growth worldwide and converged ICTs are therefore seen to bring dramatic changes to mankind. Consequently, innovativeness in this sector remains a topic of high interest. (World Economic Forum and INSEAD 2012)

The questionnaire was developed based on the auditing benchmarking Table 8 and can be found in the Appendix D. Interview input was always recorded and organised following full transcriptions.

All transcriptions were firstly organised individually in MS Word documents and for analysing transferred to MS Excel format. Company characterizations and key statements were presented in table format. Answers indicated to all the questionnaire statements were used to produce quantitative figures to compare the certified and non-certified companies' compliance to an innovation management auditing questionnaire designed in the scope of this dissertation. Conclusions were drawn based on the key statements and figures.

Further explanation on delivering the objectives of this dissertation is located together in the section about questionnaire within this chapter.

4.2 Case study

In the case study were included nine companies, five of them with a NP4457:2007 certification and four not certified companies. One of the non-certified companies had internally developed RDI management system and in another company its development was in process. It was originally planned to interview five non certified companies, however it was only possible to interview only four. Consequently the sample comparison with certified companies was incomplete. However some very interesting data was uncovered from the input obtained.

All of the certified and non-certified companies interviewed were in different sizes and business maturity. Some of them had international subsidiaries and others were locally in expanding. This was intentional to include companies from a wider perspective.

4.3 Questionnaire used for the case study

The questionnaire used during the personal interviews included nine topics as defined in the benchmarking of the studied auditing tools and in Table 9 an overview is given about the coverage.

Processes of innovation management	Questionnaire process coverage
Company characterization	Included general and financial data about the company, short explanation of their products/services, information on implemented management systems and definition of company innovation behaviour including innovation adoption (competitive positioning), type and degrees of innovation.
Organizational strategy for innovation	Included open format questions about the concept of innovation and on motivation for developing innovation management system, plus a section with questions about innovation management system. Nine statements with choices covered innovation strategy process.

Table 9. Questionnaire scope. (cont. 1/2)

Processes of innovation management	Questionnaire process coverage
Organizational culture	In the questionnaire were indicated ten innovation culture statements with choices.
Management of knowledge	Was divided into two sets of questions: knowledge management was coved with seven statements and employee training with two statements.
Creation and management of ideas	Was covered with two sets of questions: idea creation with nine statements and idea management and evaluation with six statements.
Development of products/services and management of technology and projects	Importance was attributed to the topic with 16 statements.
Commercialisation and diffusion of the products/services	Commercialization and marketing activities together were covered with 13 statements.
Management of already launched products	About management of pos-launch activities were included five statements.
Innovation outcome	Covered with seven statements.

Table 9. Questionnaire scope. (cont. 1/2)

Statements with choices (leading question type) *n/a or disagree, applies partly, applies mostly, applies totally* and open format questions were used to construct the interview guide. At the end of each block of questions respondents were ask to clarify their answers. In practice, the respondents' added spontaneously interesting statements and specifications were asked were relevant. The questionnaire was designed to be able to be completed within one hour and to facilitate this it was sent beforehand to the respondents by email.

The aim of the empirical research conducted in the scope of this dissertation is to answer two questions. Firstly, what the advantages of implementing a RDI management system based on a certified system are. And secondly, what is the implementation impact of certified innovation management system based on the Portuguese sample.

The first question on *the advantages of implementing a RDI management based on a certified system* was answered based on the open format questions responses and general comments given by the respondents throughout the interview.

The second question about *what is the implementation impact of certified innovation management system based on the Portuguese sample* was answered based on the key statements from the respondents and analysing the quantitative figures drawn based on the statements input.

4.4 Data collection

All the interviews were recorded and information was transcribed into separate questionnaire forms.. Duration of the interviews varied between 45min to 90min, average interview lasted 75 minutes.

Secondly, information was organised in a MS Excel file. Data was processed and figures presented under the results.

5 Results

Results presented in this dissertation follow the questionnaire structure that was originally introduced through the benchmarking of seven management frameworks for innovation. Company characteristics are presented in an independent section. Empirical analysis of the interview data is organised by three topics. Firstly an overview of the innovation concept input. Then, value perceived from the certification implementation impact is described by analysing the company motivation for certification and insights given by other companies. Finally certification impact on the system effectiveness is analysed through quantitative figures analysing the eight processes important to innovation management.

5.1 Company characteristics

Case study were analysed both the national standard NP4457:2007 certified companies and standard not implemented companies in different business development and company size. All together nine mainly Portuguese origin information technology (IT) companies were interviewed.

This sector was chosen because previous study revealed that this sector has the highest standard NP4457:2007 adoption rate. Moreover, aspects from global economical development also supported positively the sector relevance.

The group of certified companies includes three small and medium sized companies (SMEs), one large sized company and one startup company. Two of the SMEs and the medium size company show reasonable market maturity. See Table 10 with NP4457:2007 certified companies' information.

The group of non-certified companies included mainly companies still in the startup phase and one market established large sized company. See Table 11 for general characteristics of the companies not NP4457:2007 certified.

In the table are indicated: company foundation year and their main products/services, number of workers (in case of certified companies that number is directly related to the NP4457:2007 certified RDI system), where possible sales behaviour and investment in RDI over the last three years between the years 2010-2012 are indicated.

For certified companies the year of NP4457:2007 certified RDI management system, access to consulting and duration of the standard implementation period are presented.

Not certified companies were asked if they have a formal process for RDI management. Also was identified whether the company had implemented other management systems (mostly ISO 9001 was identified).

All the companies were asked to describe their innovation behaviour concerning whether they are first-to-the-market, fast followers or late followers. On the product, service, process, organizational, business model and marketing level they identified how they consider their innovation degree on the scale of incremental, balanced, and radical.

General Characteristics		Company A	Company B	Company C	Company D	Company E
Year of foundation		1998	1999	2001	2007	2008 (2011)[29]
Number of workers/RDI related[30]		230 / 40	24 / 14	33 / 8	28 / 28	4 / 4
Main products/ services		Specializing in developing reliable solutions, services and technologies for information systems	Development of laboratory software for different market segments and consultancy	Software development, for different segment markets (Health, Telecommunications, etc.), customized ICT solutions	Ingest solutions for video production and broadcast industry	Development of interactive 3D software application for leisure and business purposes
Sales behavior/ investment in RDI (during the period of 2010 – 2012)		N/A / 10-15%	Mainly local market / 15-30%	Local market only / ~ 5%	Mainly exportations / ~30%	N/A
Year of RDI management system NP4457:2007 certification		2010	2009	2011	2011	2012
Duration of the implementation		1 month	9 months	24 months	8 months	6 months
Access to external consulting team for implementation		Yes	Yes	Yes	No	Yes
Other management systems certified	**ISO 9001**	✓	✓	✓	In progress	-
	ISO 14001	-	-	-	-	-
Innovation behavior		First to the market Fast follower	First to the market	Fast follower First to the market	First to the market	Fast follower First to the market
Innovation degree	**Product**	Incremental	Balanced	Balanced	Incremental	Balanced
	Service	Balanced	Incremental	Incremental	-	Incremental
	Process	Radical	Incremental	Incremental	-	Incremental
	Organizational	Balanced	Balanced	Incremental	-	-
	Business model	-	Incremental	Incremental	Balanced	Incremental
	Marketing	Incremental	Incremental	Incremental	Incremental	Incremental

Table 10. General characteristics of the NP4457:2007 certified companies.

[29] The company was legally established in 2008, but only started running in 2011.

[30] Number of workers in the company in 2012 affected by the NP4457:2007 / Number of workers directly involved in the RDI activities.

General Characteristics		Company F	Company G	Company H	Company I
Year of foundation		1911	2007	2010	2012
Number of workers/RDI related[31]		434246 / N/A	5 / 5	22 / 9	4 / 4
Main products/ services		Development of product and service software technology extensions to integrate multiple applications for a smarter planet	Development of software for protecting web application source code (offered as a cloud service)	Development of CRM and invoicing applications offered via cloud computing	Development of software based on the factory assembly line principle
Sales behavior/ investment in RDI during the period of 2010 - 2012		N/A	2/3 local market (export is growing)/ N/A	Local market only / 10-15%	N/A
There is developed an internal process for RDI management		Yes	No	In progress	No
Other management system(s) certified	**ISO 9001**	✓	-	-	-
	ISO 14001	✓	-	-	-
Innovation behavior		First to the market	First to the market Fast follower	Fast follower	Fast follower
Innovation degree	**Product**	Radical	Balanced	Incremental	-
	Service	Radical	-	-	Incremental
	Process	Balanced	-	Incremental	Radical
	Organizational	Balanced	-	Incremental	Balanced
	Business model	Radical	-	-	Balanced
	Marketing	Incremental	-	-	Incremental

Table 11. General characteristics of the companies not NP4457:2007 certified.

[31] Number of workers in the company in 2012 / Number of workers directly involved in the RDI activities.

5.2 Presenting and analysing the empirical data

Presenting and analysing the empirical data includes firstly companies' input on their perception about innovation concept. Secondly motivational background to NP4457:2007 certification and RDI management in general is examined throughout the respondents' comments. Some of them are added in the main body of the dissertation but due to the extensive amount of inputs it was not possible to include all of them. In Appendix E. Statements extracted from the interviews. more statements and comments from all the respondents on motivation for RDI management system, its advantages and disadvantages perceived and experienced together with general insights and with some examples of practices that companies are fostering. Some are related to NP4457:2007 certification and others considered relevant to the company RDI management. Due to the input extensively some relevant comments might not be given importance that they deserve.

5.2.1 Innovation concept characterization

The concept of innovation curiously presents very harmonious understanding among all the companies. Innovation definition according to the respondents input could be – it is a series of incremental modifications that are in our DNA which allow us to do things in a different way and that are one of our basic pillars in our daily work, moreover it is the reason why we born and what we breathe from day one mostly because of the people who are in the company and who see innovation as a strategic step to differentiate the company from the competition and face the global market. Further details on respondents input that were used to create this innovation definition can be seen in Table 12.

	Insights on concept of innovation
Company A	*"Innovation is one of our basic pillars, so I would say that it is in our daily work. It is mandatory for us! "*
Company B	*"It's a series of incremental modifications, improvements in the product and in an organization."*
Company C	N/A
Company D	*"From the day one, we breathe innovation. It´s the way we built the company, to create innovative products, innovative solutions to our customers. Innovation and internationalization are the reasons why we born, otherwise the company would have not started."*
Company E	*"We innovate because of the people who are in the company and are leading the company; these people already have a strong innovation culture and have clearly shorted out in their heads the differentiation, positioning, strategy, surveillance, disruptive innovation versus incremental, risk, risk analyses and why it is needed."*
Company F	*"Our main motivation is part of the DNA; it is the way company was created."*
Company G	*"Innovation is how we differentiate from the competition and how we are able to face the global market. We do not have knowledge about formal innovation management systems."*
Company H	*"I see innovation like a strategic step, and I think most of the employees see innovation like an incremental process."*
Company I	*"For us innovation is to do things we do in a different way, not just because it is different but because it might have some return."*

Table 12. Respondents insights on concept of innovation.

5.2.2 Value perceived from the standard certification impact

Value perceived is analysed based on the all respondents' answers on their motivation for RDI formal system. Standard certification impact is further examined throughout the certified companies input on the advantages gained from the certification and drawbacks faced during the implementation and management of the NP4457:2007 certified RDI system.

5.2.2.1 Motivation for the RDI systematic management, system certification and relevance given to it

Value perceived from the NP4457:2007 certification impact is examined throughout respondents empirical input. Certified companies were asked to name their motivation for the NP4557:2007 certification and identify because of what reasons they consider the certification relevant (Table 13). Not NP4457:2007 certified companies were asked to bring out their motivation for RDI systematic management and future system certification.

Two of the NP4457:2007 certified companies stated that they went through the certification process voluntarily (company A and B); others admitted that Portuguese national RDI management standard certification came as a mandatory condition from a national incentive program.

	Motivation for the NP4457:2007 certification and/or RDI management	**Relevance attached to NP4457:2007 certification and/or RDI management system**
Company A	*"When we read the NP4457:2007 we said that we do everything that is based here so let´s certify, why not."*	*"Yes, we plan to continue with the certification. Our sector is very competitive so it is mandatory to have innovation."*
Company B	*"The adoption of the NP4457:2007 was done with our will so we have done it from ourselves and totally voluntary. For us it made total sense."*	*"We are expecting that ISO would produce the standard for innovation management, recognition from ISO will be totally different from Portuguese standard."*
Company C	*"It was one of the mandatory requirements from the co-funding programme."*	*"The certification seal distinguishes us from other companies. I think that it helps maintaining our clients and also helps us."*
Company D	*"Because we had some projects running with QREN and it was an obligation so we had to submit our system to certification."*	*"Yes, we are planning to continue with the certification as we are continuously getting new projects with QREN. I do not really see any other benefit coming for the stamp that financial."*
Company E	*"In our case the motivation was almost, let's say, an obligation coming from the QREN programme."*	*"I guess certification would make sense in a later stage of our business cycle. We are still assessing whether we want to keep with certification."*

Table 13. NP4457:2007 certified companies' motivation for the standard implementation and relevance attached to the certification obtained.

For company A innovation is a need on its markets and in fact they did prior the certification already everything that NP4457:2007 required. Their implementation process took one month due to that. Company B was the first company out of the interviewed five certified companies to obtain the certification in 2009. For them the process was curious as they say themselves.

First they had implemented the ISO 9001 standard and then after successfully developing and stabilizing all the documentation for that certification they were proposed by APCER[32] the NP4457:2007 certification. Back then the NP4457:2007 was not known by most of the companies so it was a surprise, but for them it made total sense, the CEO added "*it made total sense because that was what we were doing and it allowed us to have more formal procedures for our records*".

Company C nevertheless of being pushed to the certification knowledge that standard helped them to improve the internal processes related to innovation and according to the CEO of the company that the certification seal distinguishes them from other companies and helps maintaining their clients. Contrary, company D leader has different point of view on the certification by seeing it mainly as a stamp but still will continue with the formal process as the company is benefiting national funding incentives for the new projects. Both companies foresee continuing with the NP4457:2007 certification.

For company E, NP4457:2007 certification was an obligation that they tried to confront in a constructive way, its CEO commented: *"I think it is very complicated to maintain a standard of these, this is my opinion"*, and they are considering whether they wish to keep it or not as in their current size they see that it requires resources they do not have.

Analyse continues with the non-certified companies. Their comments are included in the Table 14.

Motivation for the RDI systematic management and system certification	
Company F	*"We are what we are and we reached this position due to innovation. So as I told, the easiest thing to say is that it is part of our DNA. And part of our values."* *[The ISO standard in development on RDI would be very interesting to company as] "[...] we want to be certified, it is very important for us to be certified. Even if in some situations, even though in some of the [existing] certification areas they are not created but supported by company internal practices."*
Company G	*"We do not have the size to justify such formalism."* *"The first step is knowing exactly what are the advantages of adopting."*
Company H	*"We are making an effort to make innovation culture as part of the company´s culture."* *"I would love to create our own approach to innovation and don´t really consider implementing the Portuguese standard."* *"I think that standards/frameworks are too much closed."*
Company I	*"I believe we have to have a minimum size in order to implement the standard."* *"I believe the smaller the company the easier it is to set up any process, but the bureaucratic part is that put as always with some thoughts before starting these things."*

Table 14. Non-certified companies motivation for RDI systematic management.

From the not certified companies reveals that one of them, company F, has internally developed RDI management system. Company H is in a process of integrating innovation

[32] Portuguese Association for Certification.

culture as part of the company culture. CEO of the company H comments: *"I spoke with some companies to understand the framework and some guys were really enthusiastic of the frameworks and some people said to be careful as sometimes these frameworks put too much bureaucracy and that is the problem".*

Company G and I do see it beneficial the RDI management and have implemented some practices although due to their small size both of them exclude the possibility of voluntarily adopting a formal RDI management system in their current development phase.

Company F nevertheless expresses curiosity and openness towards the ISO standard in development for RDI certification. They justify the development of RDI management system with the internal need and adds that certification would be very important for them.

When looking at all the nine companies' responses, the more mature the company is the more likely they are interested in formal RDI system adoption. Company A, B and F are the good examples of that. Company C could be considered to be on the side of the voluntary fostering of RDI systematic management as they present strong interest to continue with the certification.

Company D shows positive evolution in developing voluntarily a management system, nevertheless certification in the current situation was faced more as an obligation. Company H shows a similar profile with its internal development of systematization for the RDI process. Looking at the first group of companies (A, B and F) company D and H present pre-behaviour phase which first group of companies had fostered prior the certification or formal internal process for RDI management.

Company E, G, I are all small sized startup companies and too formal process for RDI management is not considered beneficial as the communication is very much agile.

5.2.2.2 Main benefits and difficulties indicated by the certified companies

In the Table 15 are collected main advantages and disadvantages of the NP4457:2007 certification. The benefits named by certified companies are the routinization and more structured processes and information. All the companies agree that standard can help to foster and drive a change in the company. Company E CEO stated on the topic: *"Standard is an antibody that helps to bring the changes and influence people that otherwise would be almost impossible and therefore can be seen as an instrument of change",* he considered the standard very important from that point of view.

Difficulties related to Portuguese standard certification are mainly the bureaucracy it bring and the fact that a certification requires human resources to manage it and in relation to that a certain dimension from the company. Company B brings a nice example by describing that for doing all the records they internally developed software to manage everything digitally, *"it is important part of the implementation and allows eliminating all the bureaucracy and the administrative procedures that do not have any value to the organization."*

	Company A	Company B	Company C	Company D	Company E
Advantages/Benefits	*"Main thing that we have gained is the more structured information."* *"The standard helps systematize knowledge."* *"The standard can be a driver of change."*				
	✓	✓	✓	✓	✓
	"Documentation improved with the certification."	*"[...]more systematic approach and more structured activities."*	*"New channels were created in support of systematization, timeline definition […]"*	*"[...] things are more organized[...]"*	*"An area that improved a lot was that of interface management"*
Difficulties/ Drawbacks	Standard needs people to keep it which further require a certain dimension from the company.				
			✓		✓
		"It is an error for me if a company who does not have implemented any standard start implementing RDI standard as a first standard."	*"If we had more people in the team, things* [idea management] *could work out better"*	*"For very small companies I doubt that the system becomes economical but for big companies yes, I believe."*	*"For a company with our size […] a standard like this is difficult to keep […] You need to have dedicated people to it".*
	"There is a bureaucratic side in the standard."				
	✓	✓	✓	✓	✓
		"The things existed already and we did them, but not in a formal way"	Some *"things are done because they have to be done"* according to the standard. Running the system effectively "*requires time.*"		*"In the beginning there was some natural resistance as we were only four and communication was very agile and tacit."*

Table 15. Main advantages and disadvantages identified from NP4557:2007 certification.

5.2.3 Certification impact on the system effectiveness

This chapter includes eight sub chapters, each of them characterising the case study sample from one process of innovation management. Firstly, short description of the questionnaire statements is presented, (full questionnaire found in the Appendix D. Comparison of the behaviour of the certified and non-certified companies´ innovation management compliance is introduced. Answers considered favourable and in compliance with the innovation management practices are the applying totally and applying mostly responses. In analysis, where relevant, are added some key statements from respondents.

Answers from all the respondents were summed up in each predefined choice in calculating values for analysis (*n/a or disagree, applies partly, applies mostly, applies totally)* For example, as the company strategy for innovation had nine statements and the case study included nine respondents, then for the five certified companies 5x9=45 maximum responses that are distributed among the four choices. For four non-certified companies the calculation

would be 4x9=36 for all responses. All according data can be found in Appendix F. Figure style used situated data input on the scale of 100% that allowed direct comparison between the bars (certified and non-certified companies).

Based on analyse was possible to conclude that not all the processes had been influenced by the certification impact. The ones coloured in the Table 16 are considered to benefit higher effectiveness due to the certification impact.

Processes of innovation management	Certification influence			
	Not identified	*Slight*	*Medium*	*Strong*
Organizational strategy for innovation				✓
Organizational culture	✓			
Management of knowledge		✓		
Creation and management of ideas	✓			
Development of products/services and management of technology and projects			✓	
Commercialisation and diffusion of the products/services				✓
Management of already launched products	✓			
Innovation outcome				✓

Table 16. Innovation management certification influence on each process[33].

5.2.3.1 Company strategy for innovation

Company commitment to innovation was evaluated throughout nine innovation strategy statements: whether the company has an innovation philosophy; has a defined innovation strategy and if the strategy is documented and well-communicated internally; has an action plan for strategy, if the action plan has measurable objectives; has segmentation practices, competitor analyses; processes to identify their customers and if they had responsible for innovation manager.

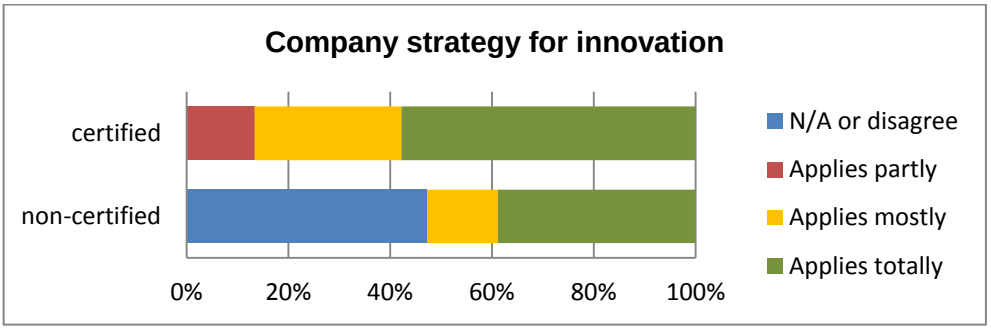


Figure 3. Comparison: company strategy for innovation.

[33] Coloured processes are considered to benefit certification impact.

Figure 3 indicates that certified companies favorable result demonstrate higher compliance level, over 80% compared to non-certified <50% in innovation strategy process. Zero responses in the certified disagree category indicate that all the five companies have at least on some level their innovation strategy defined, documented and communicated internally. From the more mature companies reveals that they do it mostly voluntarily but starting companies rather say that this factor has came as an obligation and sometimes in reality does not make much sense to them. This could be due to the fact that certification requires defining and documentation of innovation strategy from the companies who without the certification would put less effort on it. Non-certified companies compliance is strongly influenced by well market-established and mature company F who has internally developed a RDI management system. Certification can be considered to have relevant importance in the process.

5.2.3.2 Organizational culture

Process of organizational culture includes ten statements that give insights about company behaviour towards activities developed to support innovation culture. Is the innovation management attributed importance by top management, are employees encouraged for creativity, innovation, learning from the mistakes and are their working conditioner flexible in terms of dress code, timetable, location and whether they love to come to work. Through statements comes clear that on what extend does the company invest in employee development and provides internship positions. Also is asked if the innovation culture is part of the marketing strategy.

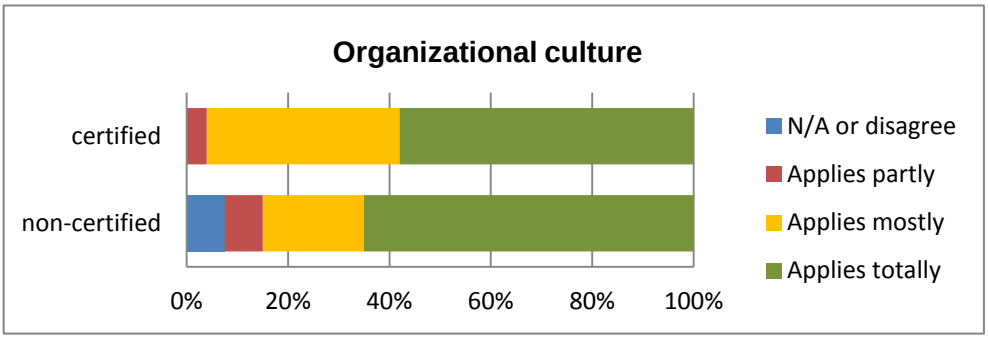


Figure 4. Comparison: organizational culture.

Based on the Figure 4 can be identified a strong innovation favourable culture in both respondent groups. For certified companies reality shows around 95% and for no-certified companies around 85% for the organisational culture process compliance. For all the companies fostering a supportive environment for value creation is crucial. Intriguingly, category of total conformity to organizational culture statements was indicated more often by not NP4457:2007 certified companies. This could be justified with a statement from company B, *"if the company does not have an innovation culture, I do not believe that implementing the standard will improve that*". Certification positive impact cannot be clearly identified.

5.2.3.3 Management of knowledge

Management of knowledge process is covered by two blocks of statements – knowledge management and employee training - all together with nine topics with choices.

Knowledge management includes seven question starting from identifying whether the company does do the SWOT analyse compared to its competitors, has defined essential

technological areas and critical markets. Also, either it maps competences required for competitive advantages through innovation, systematises internal and external information for regular use and has methodology for systematic dissemination and management of knowledge together with a responsible for this process.

Employee training two statements examine whether company elaborates internal training sessions and encourages its employees for continuous professional learning and personal development.

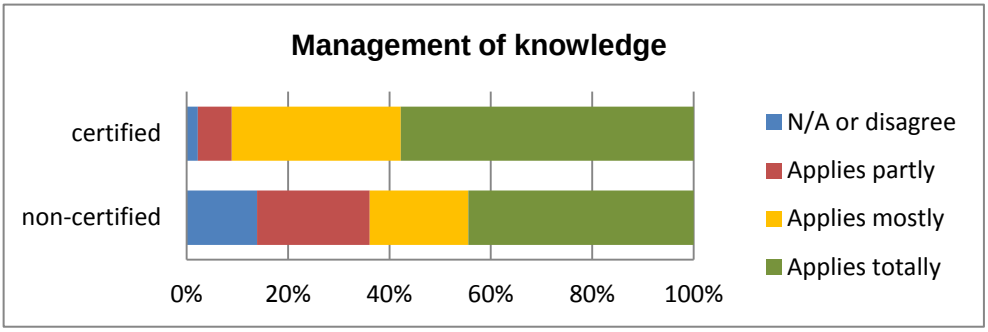


Figure 5. Comparison: management of knowledge

Results based on the Figure 5 indicate approximately 90% favourable compliance situation for the certified companies with all the companies showing very similar behaviour, and <60% for the non-certified companies. Majority of the non-certified companies´ (SME and startups) show moderate compliance in the process, only well-market established company shows total conformity in this aspect. This could be justified by the fact of company maturity. Certification seems to bring benefits in this process by improving the systematization and documentation of the knowledge.

5.2.3.4 Creation and management of ideas

Like the name says, process of creation and management of ideas involves two main activities which are covered by 15 statements.

Idea creation examines if all the employees are involved in the idea creation and can add them spontaneously, whether regular activities are held to generate ideas or workers are given extra resources (time, fiancé, etc) and if all the generated ideas are in reality registered. Also, this block of questions looks into process aspects about cross functional fertilization and partnerships established with external bodies and whether customer feedback is systematically captured to feed input into idea creation from various sources.

Management and evaluation describes the extent to what the process for idea management has been implemented, and if its activities managed are systematically communicated to the employees. Also is examined whether ideas are managed within the idea portfolio and if all of them are given a chance in the evaluation process.

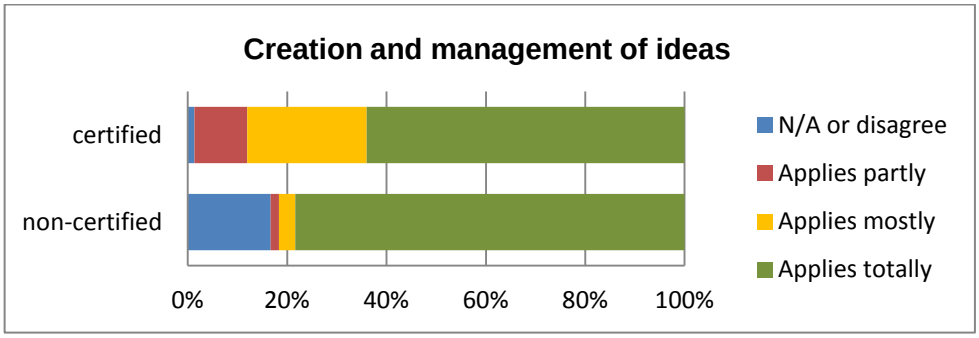


Figure 6. Comparison: creation and management of ideas.

Figure 6 indicates idea creation and management trend among the certified and non-certified companies samples. Both show high compliance, over 80%. Moreover, total conformity category of the non-certified companies presents significantly higher systematically practiced creation and management of ideas. This fact could be related to the startup nature of being creative and to the need of developing the company niche. Therefore, creation and management of the ideas as the origin of innovation are every time given a more systematized approach, dedication and importance. Certification does not seem to bring higher efficiency in this process.

5.2.3.5 Development of new products and management of technology and project portfolios

New products development process involved questions on whether the company uses methods designed for new product/service development (Agile Software Development, SCRAM, LEAN, etc) and process design (design to cost, quality function development, etc). Also, if it practices risk management activities and has set milestones for new launches according to the business strategy.

Statements covered development process funding availability, systematization, and evaluation criteria. Also identified was whether the development process defined meets the market conditions and project requirements and whether the teams involved were multidisciplinary. From the market acceptance side it was asked whether the company undertakes field tests, applies lead user to obtain information or practices development hand-in-hand with the client.

Respondents were asked whether the knowledge management effectively contributes to disseminating best practices and could the small and priority projects move quicker through the project pipeline if requested. They also identified whether the company has R&D unit and does management of this area has a responsible named.

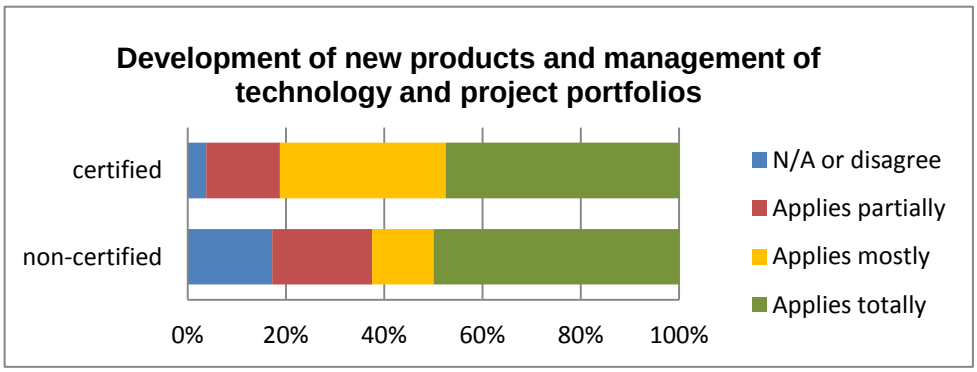


Figure 7. Comparison: development of new products and management of technology and project portfolios.

Figure 7 identifies stronger statement compliance in the certified group being <80%, in the non-certified <60%. When we look to the total conformity of measures for development can be seen that non-certified companies naturally show a slightly higher accordance at 50% compared to certified sample >50%. Based on the figure could be concluded that certification has brought some benefits in the light of this process.

5.2.3.6 Commercialization and diffusion of the projects

Commercialization is a process that is not within the NP4457:2007 standard scope but has still was been covered by other frameworks. The questionnaire includes statements about whether the company has set processes to bring its innovative products/services to the market, involves channel intermediaries in the marketing team idea generation and strategy planning process and effectively identifies good practices by other companies, have the marketing and distribution activities applied an innovative approach by experimenting with new communication ideas. Does the company continuously monitor its marketing mix elements in comparison with competitors, in relation to all is the benefit ratio of promotional campaigns improving and are the market launches managed by cross-functional teams.

Also it is asked if the customer satisfaction is measured and whether the customers perceive the company products as innovative. From the results aspect are added statements on whether the company record of new developments is satisfactory compare to main competitors and is the speed of converting ideas into practical innovations improving.

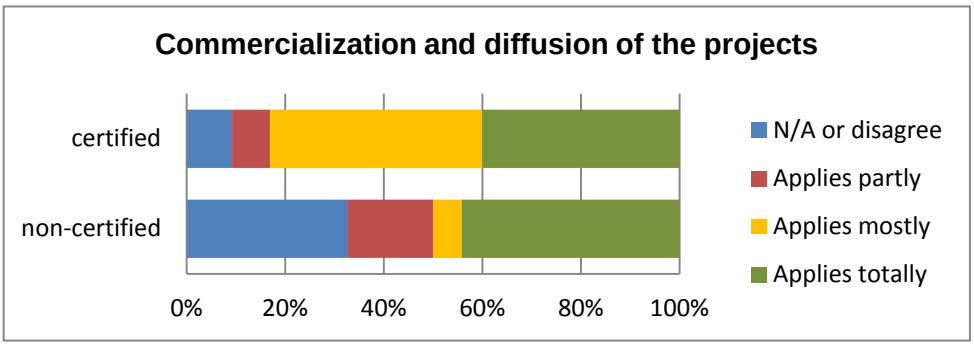


Figure 8. Comparison: commercialisation and diffusion of the products/services.

Favorable output seen in Figure 8 is dominating with <80% compliance in certified group, whereas non-certified accordance arrives to 50%. Also here phenomena of non-certified companies showing higher total adoption of the measures questioned indicates that indirect influence of the certification might have supported the statements´ compliance as favorable group of certified companies is 30% higher compared to non-certified.

This result could be due to high representation of starting companies in the sample. Starting companies in non-certified sample are compared to company E to give light to this behavior. All the starting companies show similar low non-compliance behavior. Therefore, this process is seen strongly boosted by the general management system impact especially among the starting companies and not so well market-established SMEs.

5.2.3.7 Management of already launched projects

Management of already launched product process statement block starts with questions about whether the company separates product/service improvements from new product development activities and whether there is financing for continuous improvement of already launched

products. Questions about obtaining and integrating customer feedback plus pos-launch methodology being involved in the product tailoring are asked. Statement about if there is collaborative environment between R&D and product management is included.

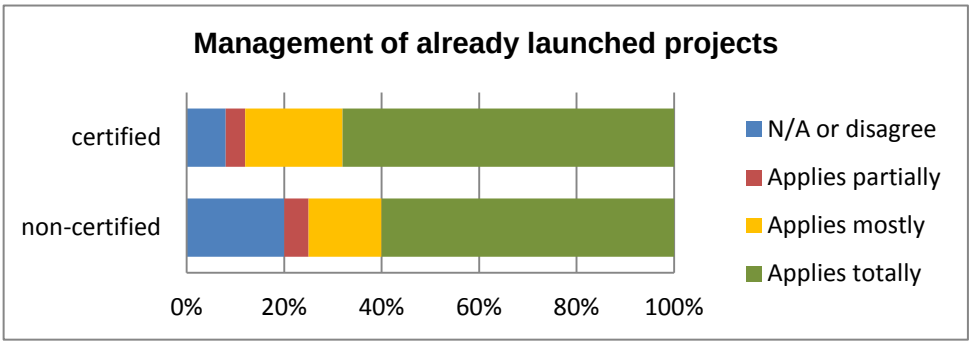


Figure 9. Comparison: management of already launched products.

According to Figure 9 pos-launch accordance to the statements by both groups can be considered very similar. Certified sample shows slightly higher compliance both in favourable group and in total conformity. No significant merit to the certification impact can be addressed.

5.2.3.8 Innovation outcome

Innovation outcome process includes statements about whether the company has established indicators for controlling and evaluation of innovation management activities, if there are outcome indicators that support the development of innovation strategy according to the action plan, innovation management outcomes are discussed and analysed by top management, innovation activities contribute positively to financial development of the company, and whether the external audits serve for critical reflection about the system.

The company was asked if it has registered patents and perceives that their innovation activities have a positive influence on the industry sector.

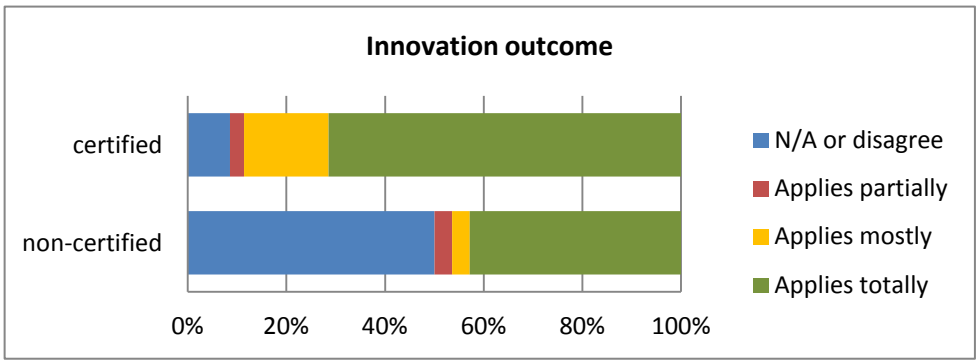


Figure 10. Comparison: innovation outcome.

Innovation outcome indicators Figure 10 show strong compliance in certified group, respectfully <80% and >50% among non-certified companies. Total conformity with the statements is considerably higher in certified group <70% compared to <40% non-certified respondents. This can be directly related to the standard requirements of establishing methodology for controlling and evaluation of the innovation management activities fulfillment. The mature companies' higher conformity to innovation outcome statements can be noted.

This process could be seen critical as involved statements are mainly related to the top management and company strategy development. Certified companies present stronger compliance in this aspect. In relation to that can it be assumed that generally the certification has been beneficial in this process.

6 Discussion and conclusions

First of all the definition of innovation according to the respondents input is:

"*Innovation is a series of incremental modifications that are in the DNA of a company, which allow to do things in a different way and that are one of the basic pillars in daily work, moreover it is the reason why companies born. Innovation is what companies breathe from day one mostly because of the people and it is a step to differentiate from the competition and face the global market"*.

To answer the research questions set in the objectives of this dissertation and described in the methodology, current discussion and conclusions chapter endeavours to draw connections between the objectives and results presented in the previous chapter.

To answer the first question "*what the advantages of implementing a RDI management based on a certified system are*", the input from all the companies has been used.

The main results reveal are: three of the companies faced a mandatory condition coming from the national finical incentive to implement the Portuguese national NP4457:2007 RDI management standard. Two of the SMEs pushed to the certification foresee continuing with the certification; One justifies the voluntary fostering with the fact that the certification helps them internally to structure the activities connected to the RDI management system and secondly considers certification important for maintaining their clients (their market is national); Other company on the contrary justified the NP4457:2007 certification with the continuous financing incentives for their new products; For the two more mature companies NP4457:2007 certification was process leaded voluntarily and they foresee continuing with the certification as they see it more as a strategic step.

Large size company involved in the case study indicated that prior to implementation of the standard they already did do everything. They identify that the IT sector is very competitive and standard has improved their documentation in favour of RDI management, subsequently foresee continuing with the certification.

Some companies also see benefits rising from the current ISO international RDI management system development in process as being NP4457:2007 certified will facilitate future ISO certification and recognition from ISO is perceived to be totally different from Portuguese standard. Author´s curiosity and motivation to this subject undergone in this dissertation was also very strongly influenced by the ISO standard development in the area of the RDI management.

Among the drawback the respondents´ experienced with the NP4457:2007 certification are the human resources it requires to maintain it. Smaller companies consider it very complicated to maintain a standard mainly from the certification point of view. All of the respondents agree and recognise the need of following the best practices but the bureaucracy introduced by the documentation is considered too heavy for starting companies where the communication is still very much agile.

To answer the second question "*what is the implementation impact of certified innovation management system based on the Portuguese sample"* was used the quantitative analyse principle.

According to the certification impact on the system effectiveness, can be concluded that organizational strategy for innovation, commercialisation and diffusion of the products/services and innovation outcome are the innovation management sub-processes that are considered to benefit the most from fostering a formal innovation management system. Development of products/services and management of technology projects shows moderate favourability towards the certified companies compliance and management of knowledge seems to be influenced slightly.

This could be associated to the fact of IT sector naturally emphasising the importance and structuring more efficiently the activities connected to organizational culture, creation and management of ideas, management of already launched products. Fostering these processes showed similar behaviour in the entire studies sample.

Generally can be concluded that the RDI management system has brought advantages namely in the formalization of the RDI activities; higher documentation and structuring of the information, and moreover in the involvement of the all the employees contribution to the company success by systematizing the knowledge. And importantly, standard can be a driver for a change in the company that without the external influence could be more complicated to implement.

6.1 Opportunities for future research

Firstly, would be interesting to involve in analyse more companies from the information technology (IT) sector to further sustain the results. The current nine companies are seen to not allow a complete and comprehensive overview.

A case study of this research was situated in the IT sector, but also could be very interesting to study the RDI standard implementation influence in the other sectors.

Moreover, could it add value a proactive RDI system manager and how are the current innovation managers. What shall be the recommendable competences of a proactive RDI system manager?

During the contact with the NP4557 certified companies was came out that they receive numerous requests to participate in the studies about innovation management which in reality they are not able to positively respond. Therefore, would be interesting to form a national organ that would gather information about all the publications and research work on innovation management (plus relevant international ones) to coordinate the interview/questionnaire flow that the companies receive. This is more a suggestion but as was rose by many respondents importance should be given to this.

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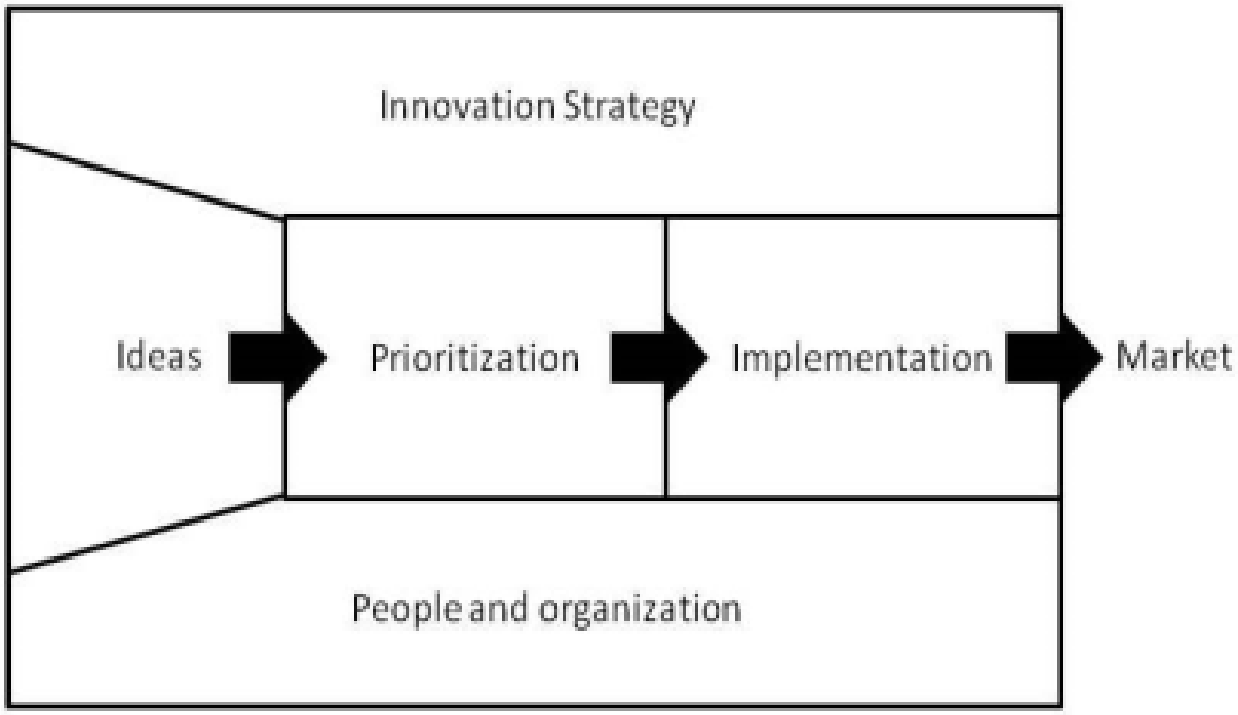
Appendix A. Interview contacts.

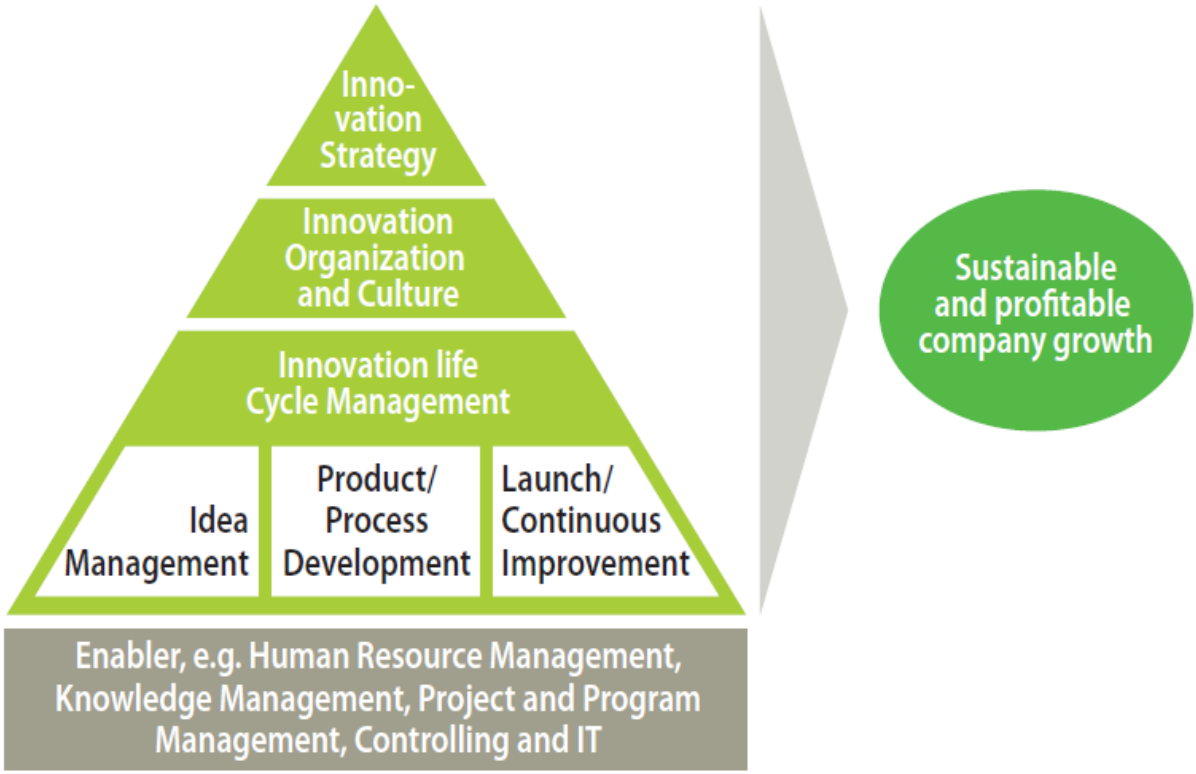
Company	Contact person	Responsibility
3Decide	Carlos Rebelo	Co-founder and CEO
Ambitada	Paulo Rego	CEO
Auditmark	Pedro Fortuna	Co-founder and CTO
Bitmaker Software	Ricardo Fernandes	Co-founder and CEO
Critical Software	Fernanda Machado	I&K Manager
IBM	José Eduardo Fonseca	Chief Technologist of IBM Portugal
MOG Technologies	Luis Miguel Sampaio	CEO
Ueb	Tiago Almeida	CEO
Shortcut	Valter Henriques	Co-founder and CEO

Appendix B. Framework graphical models in larger image.

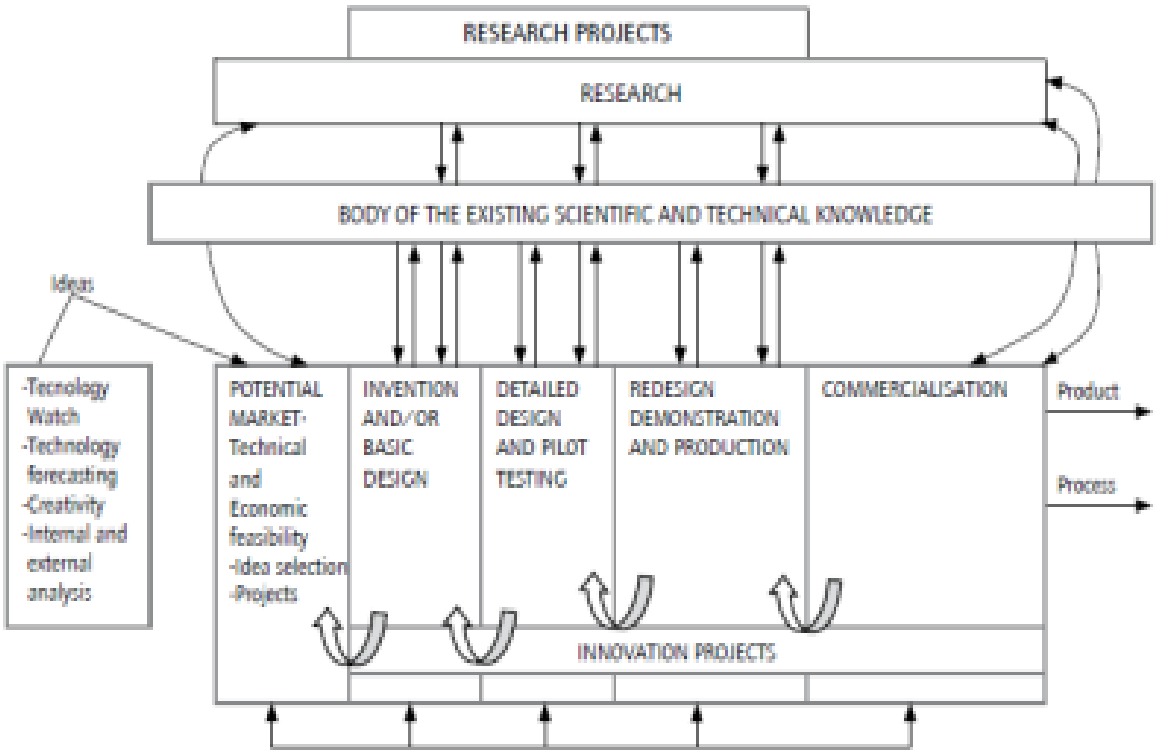
a. Keith Goffin & Rick Mitchell Innovation Pentathlon framework (2005)



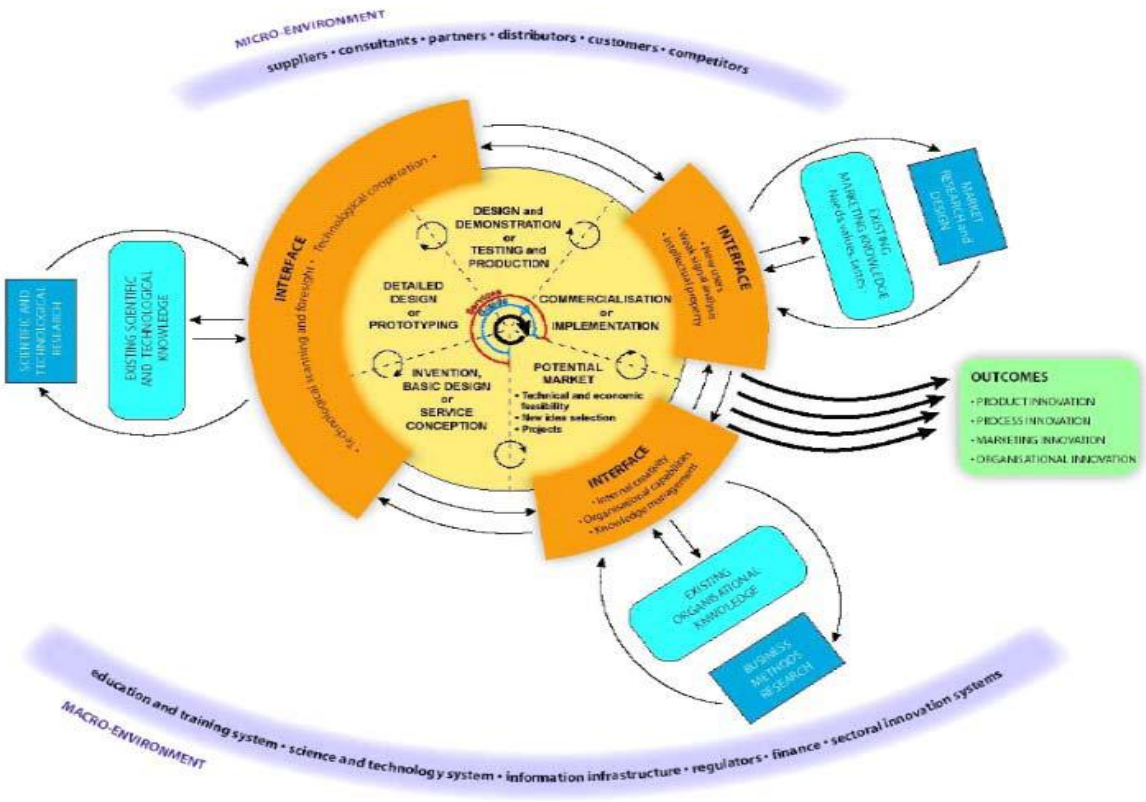
b. A.T. Kearney House of Innovation (2006)



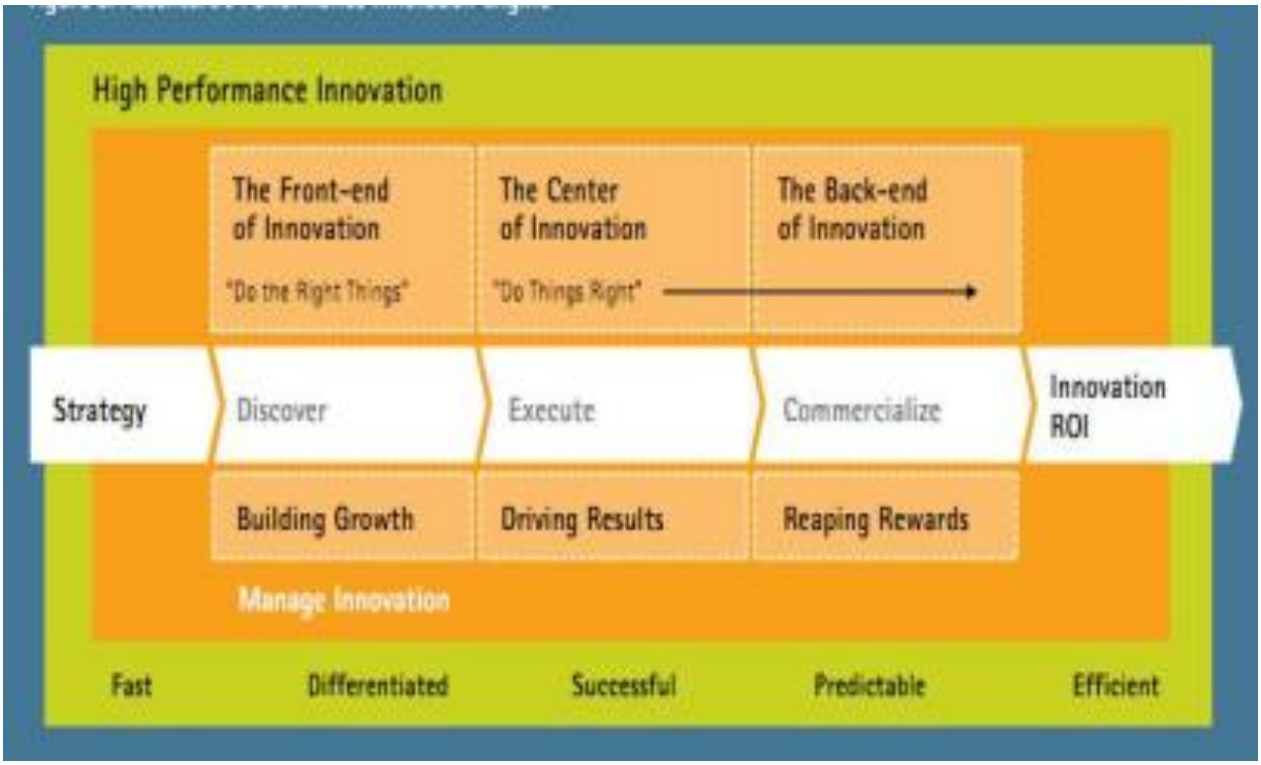
c. Spanish linear Innovation Model, UNE 166002:2006



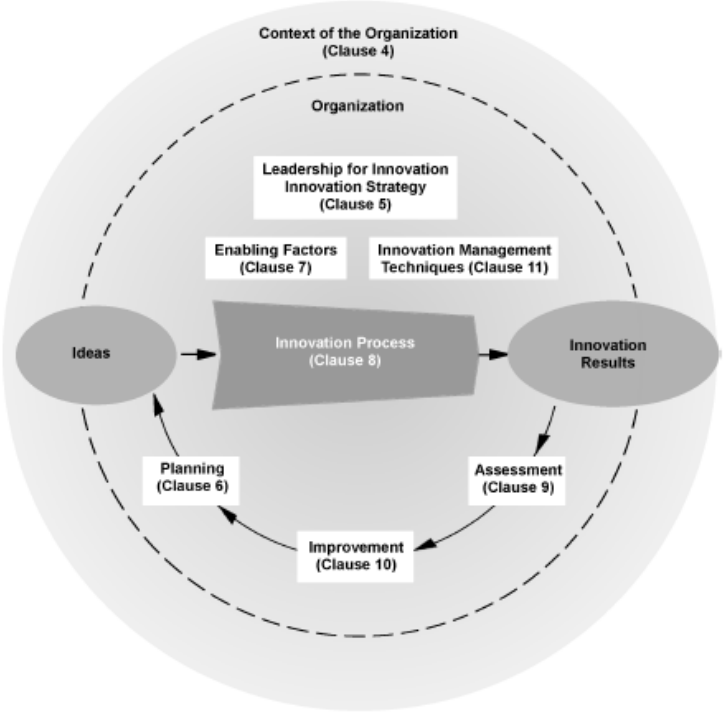
d. Portuguese chain-interactive Innovation Model, NP4457:2007



e. Accenture Performance Innovation Engine (2010)



f. CEN-Committee 389 Innovation Management, Part 1: Innovation Management System, CEN/TS 16555-1:2012



g. Arthur D. Little´s Innovation Excellence Model (2013)

Appendix C. Table of NP4457:2007certifications` RDI scope certifications.

RDI nr.	Scope of RDI	Certified companies
RDI 1	Crop and animal production , hunting and related service activities	
RDI 2	Forestry and logging	
RDI 3	Fishing and aquaculture	1
RDI 4	Extraction of coal and lignite	4
RDI 5	Extraction of crude petroleum and natural gas	1
RDI 6	Extraction and metal ores	
RDI 7	Other mining and quarrying	
RDI 8	Service activities supporting the extractive industries	1
RDI 9	Manufacture of food products and beverages	1
RDI 10	Tobacco industry	
RDI 11	Manufacture of textiles	2
RDI 12	Manufacture of wearing apparel	1
RDI 13	Manufacture of leather and leather products	
RDI 14	Manufacture of wood and cork and articles thereof, except furniture , manufacture of articles of straw and plaiting materials	1
RDI 15	Manufacture of pulp , paper , paperboard and articles thereof	2
RDI 16	Edition	
RDI 17	Printing, services related to printing and reproduction of recorded media	
RDI 18	Manufacture of coke and refined petroleum products	
RDI 19	Processing of nuclear fuel	1
RDI 20	Other chemical products and man-made fibers (excluding the manufacture of pharmaceuticals)	4
RDI 21	Pharmaceutical manufacturing	1
RDI 22	Manufacture of rubber and plastic products	1
RDI 23	Manufacture of other non-metallic products (other than the manufacture of cement, lime and plaster products concrete, gypsum, etc.)	1
RDI 24	Manufacture of cement, lime, plaster and concrete products, plaster, etc.	
RDI 25	Industries of basic metals	
RDI 26	Manufacture of metal products	5
RDI 27	Manufacture of machinery and equipment	1
RDI 28	Manufacture of computer, communication equipment, electronic and optical products	3
RDI 29	Manufacture of electrical equipment	8
RDI 30	Manufacture of motor vehicles , trailers and semi - trailers	
RDI 31	Shipbuilding and repair	5
RDI 32	Manufacture of rolling roads and rail and other transport equipment	2
RDI 33	Manufacture of aircraft and special	24
RDI 34	Manufacture of furniture, other manufacturing	7
RDI 35	recycling	
RDI 36	Production, transport and distribution of electricity	
RDI 37	Production and distribution of gas through mains	1
RDI 38	Production and distribution of steam and air conditioning	
RDI 39	Collection, purification and distribution of water	3

RDI nr.	Scope of RDI	Certified companies
RDI 40	Construction	8
RDI 41	Trade and repair of motor vehicles and motorcycles	
RDI 42	Wholesale	
RDI 43	Retail trade, repair of personal effects and household	
RDI 44	Accommodation	
RDI 45	Restoration	
RDI 46	Land transport and transport via pipelines	
RDI 47	Water transport	
RDI 48	Air transport	
RDI 49	Warehousing and support activities for transportation	1
RDI 50	Postal and courier activities	
RDI 51	Telecommunications	
RDI 52	Financial services , except insurance and pension funding	
RDI 53	Insurance and pension funding, except compulsory social security	
RDI 54	Activities auxiliary to financial service and insurance activities	
RDI 55	Real estate activities	
RDI 56	Rental activities	
RDI 57	Information technology and related activities	34
RDI 58	Activities of architecture, engineering and related technical consultancy	8
RDI 59	Technical testing and analysis	1
RDI 60	Research and development	6
RDI 61	Photographic activities	
RDI 62	Legal and accounting activities, activities of head offices and activities of management consultancy	
RDI 63	Advertising and market research	
RDI 64	Employment activities	
RDI 65	Security activities and investigation	
RDI 66	Service activities related to buildings and planting and maintenance of gardens	
RDI 67	Other services provided mainly to businesses	
RDI 68	Public administration, defence and compulsory social security	
RDI 69	Education	
RDI 70	Veterinary activities	
RDI 71	Human health activities	
RDI 72	Social activities	2
RDI 73	Collection and treatment of wastewater and waste, remediation activities and other waste management services	
RDI 74	Activities of cinema, video, television and radio, other intelligence services	
RDI 75	Travel agencies and tourism	
RDI 76	Creative activities, arts and entertainment	
RDI 77	Libraries, archives, museums, historical sites, botanical and zoological gardens and nature reserves	
RDI 78	Gambling and betting, sports, entertainment and recreational	
RDI 79	Membership organizations	
RDI 80	Other personal service activities	

Appendix D. Questionnaire.

INESC PORTO

Questionnaire about innovation management practices

PAPER ALTEC 2013

MIETE DISSERATION 2012/2013

Innovation management is every time more considered crucial and therefore this empirical work will contribute to understanding the influences perceived by companies from innovation management.

Maie Peetri*

Alexandra Xavier

Andreia Passos

Note: This present questioner is conducted by Maie Peetri, researcher of INESC TEC Innovation and Technology Transfer Unit. Obtained data will be treated with maximum confidentiality and used for elaborating scientific publications and for a dissertation in Innovation and Technological Entrepreneurship master course in FEUP about innovation management. In the written work will be done no reference to the company identities involved in the study to maintain them anonymous.

1. COMPANY CHARACTERIZATION

1.1. General data about the company	
Name of the company	
Year of foundation	
Number of workers	
Number of workers related to innovation management	
Name of the contact person	
Function of the contact person	
Main products/services of the company	

1.2. Financial data about the company	N/A	2010	2011	2012
Sales (total)				
Exportations in sales (value or percentage)				
Sales due to products/services development in the previous 3 years (value or percentage)				
Investment in R&D (value or percentage)				
Investment in innovation management (value or percentage)				

1.3. Implemented management systems	Yes (Year)	No
Quality management system (*ISO 9001*)		
Environmental management system (*ISO 14001*)		
Health and Safety management system (*OHSAS 18001*)		
RDI management system (*NP 4457*)		
Other management system		
Please specify		

1.4. Company innovation behaviour

1.4.1.Competitive positioning on the market	N/A or disagree	Applies partly	Applies mostly	Applies totally
First- to- the market				
Fast follower				
Late follower				
Customer request starts the product/service development (opposite statement would be that product/service development starts internally)				
Please specify				

1.4.2.Type of innovation	N/A or disagree	Applies partly	Applies mostly	Applies totally
Product				
Service				
Process				
Organizational				
Business model				
Marketing				
Please specify				

1.4.3.Degree of innovation	N/A	Incre-mental	Balan-ced	Radical
Product				
Service				
Process				
Organizational				
Business model				
Marketing				
Please specify				

2. COMPANY STRATEGY FOR INNOVATION

2.1. How is perceived the concept of innovation by the company and understood innovation management? (Answer generally)

	Yes	No
2.2. Has the company got systematised innovation management system?		

(If "yes", then continue here, when "no" then continue from the question point 2.4 about motivation.)

2.3. Information about applied innovation management system	
Name of the framework	
Year of certification	
Duration of implementation (months)	
Leadership of the implementation process (internal, consultant, other)	
Please specify	

2.4. Innovation strategy statements	N/A or disagree	Applies partly	Applies mostly	Applies totally
Company has an innovation philosophy				
Innovation strategy is defined and communicated to all the employees				
Innovation strategy is documented				
Strategy has an action plan with targets and measurable objectives				
Innovation performance is communicated externally				
Innovation manager (or other similar) responsibility is named				
Process is set to identify hidden or unmet needs of current and potential customers (segmentation, competitor analyses, trend scouting, etc)				
Compelling value proposition is developed and marketed				
Company has sufficient open innovation platforms and partner networks to bridge missing internal skills, competences and resources				
Please specify the applied statements				

2.5. Explain company motivation for developing (or not developing) an innovation management system

3. ORGANIZATIONAL CULTURE

3.1. Innovation culture statements	N/A or disagree	Applies partly	Applies mostly	Applies totally
Company innovation culture is defined				
Activities are developed to support innovation culture implementation				
Innovation management is attributed importance by the top management				
Top management motivates employees to creativity and innovation				
Culture of learning from the mistakes is encouraged				
Organization invests in employee/team development				
Employee working conditions are flexible (location, schedule, dress code, etc)				
Employees love to come to work				
Innovation culture is part of marketing strategy				
Traineeship/Internship programs are created				
Please specify the applied statements				

4. MANAGEMENT OF KNOWLEDGE

4.1. Knowledge management statements	N/A or disagree	Applies partly	Applies mostly	Applies totally
Competences required for having competitive advantage through innovation are mapped				
Main forces and weaknesses compared to competitors are identified				
Essential technological areas for the business are prioritized				
Critical markets/areas are defined for the company success				
Sources of internal and external information are systematized and used regularly				
Methodology is defined for systematic dissemination and management of knowledge				
Responsible for this task is named				
Please specify the applied statements				

4.2. Employee training statements	N/A or disagree	Applies partly	Applies mostly	Applies totally
Internal training sessions are elaborated				
Employees are encouraged for continuous professional learning and personal development				
Please specify the applied statements				

5. CREATION AND MANAGEMENT OF IDEAS

5.1. Idea creation statements	N/A or disagree	Applies partly	Applies mostly	Applies totally
All the employees are involved in the idea creation				
Regular activities are held to generate ideas				
Every idea is registered (evaluation comes after!)				
Employees can add/suggest ideas spontaneously				
Creation boosting tools are practices (brainstorming, mind maps, benchmarking, alternative ideas sessions etc)				
Workers are given extra resources for creating and managing ideas (time, finance, leisure, etc)				
Cross functional fertilization between members/teams/units is fostered				
Connections are established with external bodies (sharing knowledge, open innovation, etc)				
Customer feedback capturing is systematised				
Please specify the applied statements (tools and activities used for idea creation)				

5.2. Idea management and evaluation statements	N/A or disagree	Applies partly	Applies mostly	Applies totally
Ideas are registered and managed within the idea portfolio				
Process for idea management has been implemented				
Idea evaluation methodology is set and practiced regularly				
Every idea is given a chance and selected ones developed further				
Idea management is systematically communicated to the employees (activities, evaluation, results, developments, etc)				
Person for this responsibility is named				
Please specify the applied statements (how occurs your idea management and evaluation)				

6. DEVELOPMENT OF NEW PRODUCTS & SERVICES and MANAGEMENT OF TECHNOLOGY AND PROJECT PORTFOLIOS

6.1. Development process statements	N/A or disagree	Applies partly	Applies mostly	Applies totally
Funding is available for developing selected ideas				
Small and priority projects move through the pipeline quicker				
Development process is systematised and allows a wide and updated overview of the idea portfolio and/or technology and project pipeline				
Development process is adapted to the market conditions and project requirements				
There is a R&D unit/specification				
Milestones for new launches are set according to the company business strategy				

New product/service development methods and tools are used (Agile Software Development, LEAN methods)				
Evaluation methodology is set and criteria for promising product/service selection is practiced systematically				
Stringent market acceptance/field tests are made early on the development process				
Development teams are multidisciplinary				
Design process methods are used (design to cost, quality function development, etc)				
Effective knowledge management helps to capture and disseminate best practice knowledge				
Development is done hand-in-hand with the client				
Lead users are applied to obtain information				
Risk management activities are practiced				
Person for this responsibility is named				
Please specify the applied statements (methods and tools used)				

7. COMMERCIALIZATION AND DIFFUSION OF THE PRODUCTS AND SERVICES

7.1. Commercialization and marketing statements	N/A or disagree	Applies partly	Applies mostly	Applies totally
Processes are set to bring innovative products/services to the market				
Distribution and marketing activities are applied an innovative approach				
Creativity demonstrated in the promotional mix				
Elements of the marketing mix are continuously monitored in comparison with competitors				
Channel intermediaries are involved in the marketing team process of idea generation and strategy planning				
Marketing management effectively scans and identifies good practices by other companies				
Customer satisfaction is measured				
Customers perceive company products/services innovative				
Benefit ratio of promotional campaigns is improving				
Company experiments with new communication ideas				
Company´s record of new products/services development is satisfactory compared with main competitors				
The speed of converting ideas into practical innovations is improving				
Market launches are managed by cross-functional teams				
Please specify the applied statements				

8. MANAGEMENT OF ALREADY LAUNCHED PRODUCTS

8.1. Pos-launch statements	N/A or disagree	Applies partly	Applies mostly	Applies totally
Company separates product/service improvements from new product development activities				
Mechanisms for obtaining customer feedback are use to improve and update products/services				
There is financing for continuous improvement of the already launched products/services				
Post-launch methodology is more and more engaged in tailoring the products/services				
There is collaborative environment between R&D and product management				
Please specify the applied statements				

9. INNOVATION OUTCOME

9.1. Innovation outcome statements	N/A or disagree	Applies partly	Applies mostly	Applies totally
Company has established indicators for controlling and evaluation of innovation management activities				
There are indicators from innovation management activities outcome that support the development of innovation strategy according to the action plan				
External audits serve for critical reflection about the system				
Innovation management outcomes are discussed and analysed by the top management				
Innovation activities contribute positively to financial development of the company				
Company has registered patent(s)				
Company innovation activities have positive influence on the industry sector				
Please specify the applied statements (patents registered)				

Appendix E. Statements extracted from the interviews.

Motivation	
Company A	*"Well, as I said to you, innovation is a need for us on our markets."* *"**I would say that it was clear for us that when we looked at the standard we had read it and said "we have everything". When we read the NP4457:2007 we said that we do everything that is based here so let´s certify, why not."*** *"It was the company who found the standard interesting and it was neither proposed by APSER nor obliged from the QREN."* *"Yes, we plan to continue with the certification."*
Company B	*"That was a very curious process, after we had implemented the ISO 9001 in 2007, we had more or less one year to stabilise our procedures and so on. [...] we had appreciated the process and the standard and it seemed at that moment after implementing the 9001 standard a great thing."* ***"The adoption of the NP4457:2007 was done with our will so we have done it from ourselves and totally voluntary, plus did not have any funds for that.** But it was not a purpose for us, in fact we did not knew the standard very well, we had heard about it but we did not knew it and it was by suggestion of APCER that we have decided to go for the NP4457:2007. We were the 12th company in Portugal that has certified the NP4457:2007."* *"[...] in that moment COTEC was not doing the effort that is doing now to force the companies, most of the companies that were associated to COTEC to do the certification, to implement the standard of NP4457:2007."* *"It was not known by most of the companies so it was a surprise, but **for us it made total sense. It made total sense because that was what we were doing and it allowed us to have more formal procedures for our records."*** *"It made total sense to us because that was what we were doing and it allowed us to have more formal procedures for our records."*
Company C	*"[...]the implementation of the NP4457 as it was one of the obligations coming from QREN. "*
Company D	***"From the day one, we let´s say breathe innovation. It´s the way we built the company, to create innovative products, innovative solutions to our customers.** From the beginning we had a team to find always new solutions, creative solutions, to solve the problems and the needs of our customers."* ***Innovation and internationalization are the reasons why we born, otherwise the company would have not started."*** *"It was an obligation from the QREN."*

	"We started the development of a management system 3 years before. We prepared our system, but we did not have intention to certify it. It was simply the way we worked. Because we had some projects running with QREN and it was an obligation so we had to submit our system to certification. That´s why it was easy and took 8 months and we were able to have the system ready for the certification." *"**For me I don´t have any value for the stamp**. Yes, we are "planning" to continue with the certification as we are continuously getting new projects with QREN. So it is a must. I do not really see any other benefit coming for the stamp that financial. Because there are two things, one is to have the process and the other thing is to have the certification. **Certification is what I call the stamp**. The stamp is for nothing. We do not have any partners neither customers who would value the certification. "Ah, you have it, great for you! It does not make any difference for us."*
Company E	*"I think, and will be totally honest, because I think this is what the studies need. In our case the motivation was almost, let´s say, **an obligation due to QREN project**. And therefore was an obligation that we tried to confront in a constructive way in the company."*
Company F	*"Our main motivation is part of the DNA; it is the way company was created."*
Company G	*"I think that five people company perhaps do not justify having someone spending like, I don´t know how much time.., managing the whole thing is quite cumbersome."* *"We do not have the size to justify such formalism."* *"**The first step is knowing exactly what are the advantages of adopting."***
Company H	*"We are building this systematized innovation process as we and our partners are really concerned with innovation because we know we need it. CEO will be in charge of the innovation process systematization during the next year and will always stay involved in that process."* *"I study some frameworks but I would love to create our own way to approach innovation and don´t really consider implementing the Portuguese standard."* *I think that standards/frameworks are too much closed**. Part of innovation is creativity and I think that frameworks they don´t let the process to be as creative as I would like to be. So I prefer to create our own approach to innovation with no standards or frameworks.** I look to the best practices; some companies are really innovative in making things."*
Company I	*"Yes, I would be very interested but not right now. **I believe we do not have the right size.** As soon as we grow a little bit more, I believe we have to have a minimum size in order to do this. But the size cannot be so big that it is harder to implement."*

Comments and benefits of RDI management system	
Company A	*"[...] we already had all the procedures implemented and developed in the company. We just had to make small adjustments to the requirements of the standard; we did not have to do anything new."*
Company B	*"The main thing that was changed after having the standard implemented was the routines and the records that we are doing.* ***So the things existed already and we did them, but not in a formal way."*** *"****If the company has innovation culture previously before the certification, the changes will not be so big. It will be adoptions to already existing system and to have a more systematic approach and more structured activities.*** *This is the most value that it adds to the organization."* *"To have overview of everything and information extracted, even more importantly, to know which interfaces that you are monitoring that have generated knowledge to your organization. This is some kind of information that you get and is really important and something that the standard can help you to do that."* *"We are doing all the records and documenting in software, internal software that is developed by us."* *"So it is all documented in the software, we do not have papers for the procedures, it is always digitally. And it is easy to work with the software. It is important part of the implementation and allows you to eliminate all the bureaucracy and the administrative procedures that do not have any value to the organization."*
Company C	*"Standard helped to see other areas than technical (product) as areas where they could innovate. Maybe we did some already in some ways but did not feel that it was an innovation."* *"I would say that yes, the standard helped to define the scope of our innovation, but is not completely closed."* *"****In terms of innovation culture and creativity that already existed in the company (one of the forces that helped to implement the standard),*** *only there was no systematization of the processes. That was an advantage of implementing the system."* *"When we speak about organizational culture then we speak about collaborative spirit of the people, entrepreneur, we are working for all, we are all partners in terms of work."* *"Main benefit was the systematization of the process that already existed. Also where created the channels that allow this systematization and time definitions [...]."* *"Methods that allow us to do the idea management, suggestions management."* *"Innovation and creativity are included in the communication."* ***"The fact of being certified helps as to speak the same language with the companies who also are and share the problems."*** *"I think on the level of interfaces it is good."*

	"I think that the standard helps always with the systematization." *"And as there is achieve of things, for repeating questions answers can be found from there (example, this does not makes sense as was evaluated before)."*
Company D	*"Yes in the sense that the things are more organized I give value."* ***"With the certification/standardization nothing changed, just the stamp."*** *"How we systematize the information? [...] first thing is that we have a SharePoint, and we have some owners of things. [...] we have a person in charge of the standard for example. He goes to the meetings for the standard definition and every time there is a change he notice that in the SharePoint."*
Company E	*"**The standard helped to structure what was in our heads to be more sharable with the team."*** *"In some points the standard insists that there are people very dedicated to the topic."* *"One of the areas that I presume more important from the standard is the management of interfaces, doing monitoring and surveillance/vigilance. So this, in some way obliges producing reports of surveillance. I think it makes all sense to have in the CRM the information and then do sync, this has lot of value."* *"**Standard obliged and same time helped to define the scope if RDI activities of the company, understand the business focus,** obliged to define measurable RDI objectives, with real significance. Nevertheless, in the state that we are, it was not the standard that was the driving force, obliged to do this."* *"Standard helped to formalize the process of knowledge management. Obligated to report the surveillance, integration of the information in the CRM."*
Company F	*"It is part of the company the culture to share, so one is always engaged to share. When I arrived, the system was already set and it come naturally for me and one of the first sessions that I had was about innovation that company was bringing. It was normal."* *"We are what we are and we reached this position due to innovation. So as I told, the easiest thing to say is that it is part of our DNA. And part of our values."*
Company G	*N/A*
Company H	*"Innovation strategy/documentation is what we are building during the next year. It will be part of the plan to develop the strategy with defined targets to the year and to the months in order to develop new products or to increase disruptive innovation."* *"We and our partners are really concerned with innovation because we know we need innovation."*
Company I	*N/A*

Drawbacks of the RDI management system	
Company A	N/A
Company B	*"**For me it is an error if a company who does not have implemented any standard starts implementing RDI standard as a first standard.** Because if there is already standard implemented, its routines and procedures and it makes it easier to understand what you have to do. As it is only in certain activities that we do project, ideas, knowledge and so on, there need to be implemented some standardized procedures beforehand that allow that."* ***"If the company does not have an innovation culture, I do not believe that implementing the standard will improve that."*** *"Probably mapping the competences is the most important things that we could do better regarding the standard. Because the knowledge in this kind of company is the most important. Of course you need to have ideas, you need to have innovation, but in certain point it is very important to manage the knowledge that you have inside. And some of the knowledge is not structured in a formal way, it is inside of your head, and this is the most important. Well we could do better."* *"We have everything implemented and documented, what is lacking us is changing the knowledge that some people have in their head to the documents to be defused by everyone."* *"We have a lot of ideas what we call coffee ideas, when we are taking our coffee we have brilliant ideas all the time. But when we need to start thinking about them and structure them and to think a little bit more and to see the implications [...].*
Company C	***"Difficulty lies in the fact that one person wished to do everything and then starts with vices objectives and then not easily implementable in terms of system and in terms of usability as are too complex."*** *"**We will try to do a simplification as we had objectives for everything (to too many things) as many of the indicators did not bring out important results.** It was mainly helped to define but it can be seen as an obligation from the standard and most of it is formality. As there were many processes, each of them had to have objectives then objectives were developed in the way that what-will-be-put-here".* *"I think they are maybe more difficulties [...] mostly time, bureaucracy, and systematization in a good way but maybe a bit stiff. Sometimes it is not needed a meeting, but we do a brainstorming and that does not stay registered in the system."*
Company D	*"**I would say that innovation strategy is something that is impossible to create a total documentation.** In our mission, innovation policy we describe exactly what we want, in that sense yes it is totally documented. Of course it is depending, we are speaking about statements and all of them are quite wage."* *"Our action plan has targets, nevertheless have defined couple of objectives that we are not able to measure, sometimes it happens. Sometimes when we define an objective we find a way to measure it but then it is not so easy to implement it, sometimes it takes time."*

	"One year ago systematic dissemination and management of knowledge methodology was defined better than it is now. We had more internal forums and things like that but with time people start to slow down that process. So it is not so efficient at the moment." *"The reason why we have it [SharePoint] is that everybody was asking for it. But the truth is that I doubt that they use the SharePoint regularly, most of the cases they go to the system folders to have the information from there. People ask for new things but it takes some times to start using them."* *"Yes we have a process implemented for ideas management, nevertheless have been already changing it several times. Evaluation methodology is not really set and that is the reason why we had to change the process several times. What happens is that people always find barriers to use the methodology, always find excuses because of something with what they don´t agree (does not match) in the process."*
Company E	*"As constructive personal critics note that standard tends to create an association, sometimes to straight in the focus on the financial return of the things. I think it happens as a form for the standard to gain force at the same time."* *"Innovation objectives were defined, but are so called artificial/formality in a small company."* *"I think it is very complicated to maintain a standard of these, this is my opinion."* *"Yes, from the certification point of view we would maintain what is here the good practice, that's why we try to do the things from the constructive point of view so when we arrive to the end would gain something. And we gained."* *"At that time the X (responsible) had three hats (responsibilities): manager of innovation management system, manager of innovation, manager of the results of the system."* *"Standard a bit complicated, focuses more on if the things are done."*
Company F	*N/A*
Company G	*N/A*
Company H	*"I think that standards/frameworks are too much closed. Part of innovation is creativity and I think that frameworks they don´t let the process to be as creative as I would like to be."*
Company I	*N/A*

Insights on the RDI management system	
Company A	*"We normally also do the internal audits with external auditor, to have someone coming to the company and helping to identify what we need to improve."*
Company B	*"In our system are certified activities regarding investigation, development and innovation, but in fact what we do 90% of the time is innovation."* ***"I would say not to expect too much from the standard;*** *that is our discussion that we have with some of our colleagues from other companies that are also certified and others that are not certified."* ***"It will not boost you innovative capacity but you will start to have your activities more organized and to extract more information from your activities."*** *"Not to expect too much and go for the certification if you are really innovative and you need to improve your capacity of documenting your processes."* *"We are expecting that ISO would produce the standard for innovation management and when this happens, it will change completely because recognition from ISO is totally different from Portuguese standard. I think when it will appear the ISO one it will be very interesting."* *"The main activity that reinforces the innovation culture is a monthly internal meeting that we have only for this area, where people present their ideas, their projects and so on. It is connected to ideas management, to everything. To me for reinforcing the culture we need to show what we are doing so it is the main activities that we are doing."* *"We have something that is interesting and we are trying to improve it, which is trying to close the circuit between knowledge and ideas and projects and interface management. It means that for example, that if you are documenting some kind of knowledge that we have received from any type of activity, when you are documenting this knowledge, you can immediately start another procedure, for example this knowledge that I have received gives me the opportunity to implement an idea or to suggest an idea to the company. And we can connect this information, in order to after that try to understand a little bit that what the outcome of that knowledge was. This is important for us. It is interesting to know for example that maybe five documents of knowledge have produced three new ideas and to interconnect all the areas of the standard."* *"I would say to you not to expect too much from the standard that is our discussion that we have with some of our colleagues from other companies that are also certified and others that are not certified. If the company has innovation culture previously before the certification, the changes will not be so big. It will be adoptions to already existing system and to have a more systematic approach and more structured activities. This is the most value that it adds to the organization."* *"In some extent it helps a company who is not doing yet the activities obligatory to the standard implementation to improve and be more innovative but as you are not use to do it you will somehow try not to do it also in the future."*

Company C	*"ISO 9001 structure supported the implementation of NP4457:2007."* *"Before the standard there existed a culture favouring innovation, only it was not systematized. Someone had a suggestion, other commented, just that they were not registered."* *"Standard as a check-list that needs to be done. I think that innovation cannot be too much bureaucratic as otherwise it would loose some of the creativity."* *"On the other side, registration needs to occur that there would not be creativity everywhere. So it is more a compromise, a middle way."* ***"Implementation of the NP4457:2007 was one of the obligations coming from the approved QREN financing."*** *"Formal certified system has some value for us, one thing is to innovate and other to have the certification."* ***"I think that it helps maintaining our clients and also helps us. Also on the level of applying to QREN we should be more beneficial compared to the situation if we would not be."*** *"As also big part of our clients are related to the RDI management the fact us being certified supports the business negotiations and partnerships."* *"So yes, for now we are planning to continue with the certification. We see that having the formal certification is something that distinguishes us from other organizations."*
Company D	*"First we have in Portuguese the innovation and quality system. Then we changed to English and we call IMS, integrated management system because we want to be ISO certified as well. So that is why we are creating a single system to combine the certification for innovation and ISO (for quality management). "* *"The person who was in charge of the preparation of the system had previous experience with the standard. And that facilitated the implementation process."* *"First did the process for innovation management and now are in progress with quality management system implementation. "* ***"If I have to make cost-benefit analyses in terms of money we are not big enough to have impact on that. We don´t have more economical beneficial from that. I believe that bigger teams yes, it saves money. For smaller than us teams, maybe they spend money with the system instead of getting money. For very small companies below 10 persons I doubt that the system becomes economical or brings economical benefits to the company.*** *But for big companies yes, over 50 people I believe."* *"We have more innovative ideas that we are able to implement. [...] If funding is not available for the selected ideas we´ll find it."*
Company E	*"On the level of implementation it is related to resources and the company is small and standard sometimes has excessive weight as the company does not have departments yet to answer all the questions related to investment turnover."* *"We innovate because of the people who are in the company and are leading the*

	company, these people already have a strong innovation culture and have clearly shorted out in their heads the differentiation, positioning, strategy, surveillance, disruptive innovation versus incremental, risk, risk analyses and why it is needed, investment turnover analyses, what is the effort needed – people already live that. If it would be only standard, then it would be very complicated because the standard simply systematizes the knowledge." *"Standard is an antibody that helps to bring the changes and influence people that otherwise would be almost impossible and therefore can be seen as an instrument of change. And from this point of view the standard is very important."* ***"I think the standards serve for obliging people to change. Changing people is very complicated!"*** *"If there would not been obligation then certification would have made sense in another life cycle of the company."* *"Company has liberty of choosing which is very important* - ***flexibility in choosing the tools – standard does not impose any tools.*** *As I´m a technologist, so in the nature I would try to refuse it."* ***"Standard will help to support the organic growth of the company."*** *"NP4457:2007 was the reference for innovation management system in Europe and as a standard considered interesting by the CEO."* ***"In our case the motivation was almost, let´s say, an obligation due to QREN project.*** *And therefore was an obligation that we tried to confront in a constructive way in the company."*
Company F	[The ISO standard in development on RDI would be very interesting to company as] *"[...] we want to be certified, it is very important for us to be certified. Even if in some situations, even though in some of the* [existing] *certification areas they are not created but supported by company internal practices."* *"To put development process rolling it takes some time. "Who said elephants´ can´t dance" has been written by one of the company leader. Who says elephant means the big like our company can´t dance, yes we can dance. When you look at the elephant, it takes time to start, to walk but then when it is moving it can do miracles. That is the point, sometimes it takes some time because the company is too big but then because it is too big it can role really fast."*
Company G	*"If the management systems, innovation management system, would be like the only thing that would guarantee us success, but we do this in non-formal way, so we don´t feel that by not implementing this we are left with nothing.* ***We do that but just without the written document.*** *I understand the need for the system with larger cooperation. But here with five people, it is like a flat agile structure of innovation."* *"****Innovation is how we differentiate from the competition and how we are able to face the global market."*** *"We do not have knowledge about formal innovation management systems."* *"As everyone shares the innovation philosophy it is the culture of innovation for us."*

	*"**Registering ideas is mandatory!** This is our philosophy of innovation, so we have to do that."*
Company H	*"I see innovation like a strategic step, and I think most of the employees/team see innovation like an incremental process."* *"I don´t think this is the better way to see innovation and I would love**, and we are trying to do that effort to make innovation culture as part of the company culture.**"* *"My company people are innovative by nature."* ***"I spoke with some companies to understand the framework and some guys were really enthusiastic of the frameworks and some people said to be careful as sometimes these frameworks put too much bureaucracy and that is the problem."*** ***"I believe that the main reason for the companies using the standard is QREN and the interest to bring some money/investment to the company."*** *"Our philosophy is also our culture, and it reveals in our products."* *"Some of our values are clearly written and all company staff knows our values."*
Company I	*"For us innovation is to do things we do in a different way, not just because it is different but because it might have some return."* *"So it is kind of natural things also as we are startup and we are among other startups. So we have kind of innovation philosophy."* *"I believe the smaller the company the easier it is to set up any process, but the bureaucratic part is that put as always with some thoughts before start these things."*

Some practices related to RDI management	
Company A	*"We have a system that supports all of our projects which is lessons learned and everyone that works on a project must fill in at end of the project the lessons learned. This means mistakes; this means cases of success, but mostly mistakes."* *"We have a program that is called ITIs, there is ideas to income that we have to all employees to submit their ideas and to share their ideas with us."* *"Yes, we invest in employee and team development. For example, [...] we are going to have a radical weekend with all the employees. And we have team building activities regularly."* *"Office is opened 24h."* *"We have PhDs here and we also have university that come to make small projects."* *"For registering ideas we use an internal tool that we have created for that."* *"In the old program we had an activity that was innovation time, that we give time to some workers to develop an idea."* *"We use brainstormings, we have benchmarking, discussion forums, wikis."*
Company B	*"Unfortunately, we do not have traineeship programs with universities because [...] we have not recognised the universities to have, well, knowledge that could be interesting for us and that interchanging information between universities could be good thing."* *"[...] sometimes when we have specific activity that we need one guy to do it by a specific date, it is more productive if you send this people to their home and they do it at home. And we have done that several times. But it is not usual; usually they come here to work [...]"* *"We have a digital whiteboard, something like this, where people start to register these ideas, coffee ideas that I've told."* *"In fact we do not give extra resources for the people to manage ideas. We had in the past an idea to do that. It was to have, well Friday in the afternoon something like that, a period of time when you do not work on anything else, you are totally available to think about ideas and so on. But we not implemented that."* *"We did do the forums before the certification every week. We still do the things but not so often. It is not question about motivation because of the certification."*
Company C	*"We made a workshop day. Include all the organization, also students from FEUP and objective was to create a technological roadmap. We used a workshop where training was given on the level of marketing innovation and organizational innovation, innovation in the human management that allowed us in the end of the day to have a matrix with technological roadmap for 2015. Project ran funny way, we all went the whole day out to the street. Started with breakfast with all the employees, then there was the workshop with a trainer about creativity and innovation, teams where formed, the teams went to work where they wanted, in the afternoon we*

	gathered and each team presented their conclusions.It is part of the human resource management and in principle we will repeat it during the next year." *"Now we have a SHOUT initiative."* *"We have the suggestion box and idea management process."*
Company D	*"Top management encourages employees to creativity and innovation, nevertheless not all the time they are opened to it.* *"We have post-mortem analyses. When a project finishes, we analyse what went good and what went wrong, bad, how to improve. And also when we are, when we set a new responsibility we teach that person what is its responsibility and then we make like a situation point, we create some milestones to understand if the culture that should be used for these responsibilities is done or not."* *"We do not hire anybody if it is not a long term contract, so it is culture and a way we face the employment process."* *"We have mostly partnership with FEUP, we launch thesis proposals."* *"For generating ideas we have what we* ***call the roundtable and forum.*** *Any employ could create a roundtable and invite other workers and brainstorm there the idea, implement it and then if it is an idea that does to the development then the roundtable do that also in the SharePoint."*
Company E	*"Meetings in every 15 days to share the new developments. CEO presents the customer feedback to programmers and they give their comments, new ideas."* *"We have a policy for idea management"*
Company F	*"When we have a problem, and something goes wrong we always have to do a RCA, root cause analyses, the 5 whys what was the problem, to learn from the problem. Because we cannot pretend that it did not happen so the best way is to understand, face it, learn and correct."* *"We do not really organize company weekend activities to employee development, we use to until a certain size, it would be too costly."* *"We organize ourselves internally in wikis and communities in developing and teaming because teaming is not just teaming you and me, the guys that could be with me in the room but teaming is someone like me* [globally]." *"Yes, there we have a set of forums, a set of* ***wikis that allow us to team globally****, and does not have to be teaming face-to-face. The teaming, because we are a global company, is much more than face-to-face, it is more working in the communities."* *"We do lot of trainings, we have e-leaning platforms with lot of contents, internal contents. Also being a market leader means that there are not many external sources for information but we have to also elaborate the training sessions internally."* *"Registering the ideas comes naturally, in the intranet there is – get connected, participate – so it is easy."* *"We have a process owner for every single process and every process has a set of approvers, every document has front page, two pages for control and sometimes*

	happens that the document itself is one page. In the control we have the process owner, document owner, reviewers, approvers; all of it is part of the documentation. Also the history of change control, with the date."
Company G	*"We do traineeships regularly and have had almost 20 trainees here; from FEUP we have had 15. It is part of our innovation process, because we have these ideas bubbling all the time regarding to our products and future products."*
Company H	*"We pay our employees outside trainings, workshops."* *"We have a program, we select young students on their second year, we make some interviews with them, we choose two, we pay them the rest of their bachelor, so they have two years working just 8h per week with us, and we pay all the bachelor. When they finish that level, they make their internship with us, and next if they are good they stay."* *"Hope that my workers love to come to work, I would love to have better place but at the moment our office is that. We have good conditions, we have a kitchen, they can rest here, have lunch here, and they see some TV here. It is important for me that [workplace] is part of their life, (integrate workers socially), we make some dinners, we make some trips, we make some surfing, (workers feels that they are friends)."* *"We have totally horizontal management, […] communication it totally informal."* *"That is important that we do not have any doors in our office, just in the bathrooms! That is something that we decided to do when we designed our office, we decided to use no doors. I do not have any door at my office."* *"We do not have any doors in our office, expect in toilet."*
Company I	*"Once in a while move to a coffee shop for brainstorming, use also other methods for idea creation.*

Appendix F. Data of the figures.

	N/A or disagree	Applies partly	Applies mostly	Applies totally	N/A or disagree	Applies partly	Applies mostly	Applies totally	N/A or disagree	Applies partly	Applies mostly	Applies totally	N/A or disagree	Applies partly	Applies mostly	Applies totally
	Company strategy for innovation				Organizational culture				Knowledge management				Creation and management of ideas			
Company A	0	0	2	7	0	0	2	8	1	1	2	5	0	0	5	10
Company B	0	0	4	5	0	0	5	5	0	0	3	6	0	2	3	10
Company C	0	2	1	6	0	0	2	8	0	0	2	7	0	0	2	13
Company D	0	1	4	4	0	2	4	4	0	1	4	4	1	3	6	5
Company E	0	3	2	4	0	0	6	4	0	1	4	4	0	3	2	10
Total	0	6	13	26	0	2	19	29	1	3	15	26	1	8	18	48
Company F	0	0	0	9	0	0	1	9	0	0	0	9	0	0	0	15
Company G	5	0	3	1	2	1	6	1	2	2	3	2	0	0	1	14
Company H	8	0	1	0	1	2	0	7	1	4	0	4	0	0	1	14
Company I	4	0	1	4	0	0	1	9	2	2	4	1	10	1	0	4
Total	17	0	5	14	3	3	8	26	5	8	7	16	10	1	2	47
	Development of new products				Commerzialization and diffusion of the products				Management of already launched products				Innovation outcome			
Company A	0	0	3	13	1	0	8	4	0	0	1	4	0	0	1	6
Company B	0	4	6	6	0	1	7	5	0	0	1	4	0	0	0	7
Company C	0	2	4	10	0	0	4	9	0	1	0	4	1	1	1	4
Company D	0	3	8	5	1	3	6	3	1	0	1	3	0	0	2	5
Company E	3	3	6	4	4	1	3	5	1	0	2	2	2	0	2	3
Total	3	12	27	38	6	5	28	26	2	1	5	17	3	1	6	25
Company F	0	2	0	14	1	2	1	9	0	0	1	4	0	0	0	7
Company G	5	6	3	2	3	6	0	4	0	1	1	3	4	1	0	2
Company H	1	5	1	9	6	1	0	6	0	0	0	5	4	0	0	3
Company I	5	0	4	7	7	0	2	4	4	0	1	0	6	0	1	0
Total	11	13	8	32	17	9	3	23	4	1	3	12	14	1	1	12